NATURE CURIOUS & BEAUTIFUL

RICHARD KERR, F.G.S., F.R.A.S.

WITH [illegible] ILLUSTRATIONS

To Donald Long
from his
Affectionate Friend
M. Turner.

December. 1903.

Nature—Curious . and Beautiful .

'Speak to the earth, and it shall teach thee.'
(SOLOMON)

'O mickle is the powerful grace that lies
In herbs, plants, stones, and their true qualities;
For nought's so vile that on the earth doth live,
But to the earth some special good doth give.'
(SHAKESPEARE)

'Thou usest all Thy works—
The weakest things that be;
Each has a service of its own,
For all things wait on Thee.

Thou usest tree and flower,
The river vast and small,
The eagle great, the little bird
That sings upon the wall.

Thou usest the wide sea,
The little hidden lake,
The pine upon the Alpine cliff,
The lily in the brake,

The huge rock in the vale,
The sand-grain by the sea,
The thunder of the rolling cloud,
The murmur of the bee.'
(BONAR)

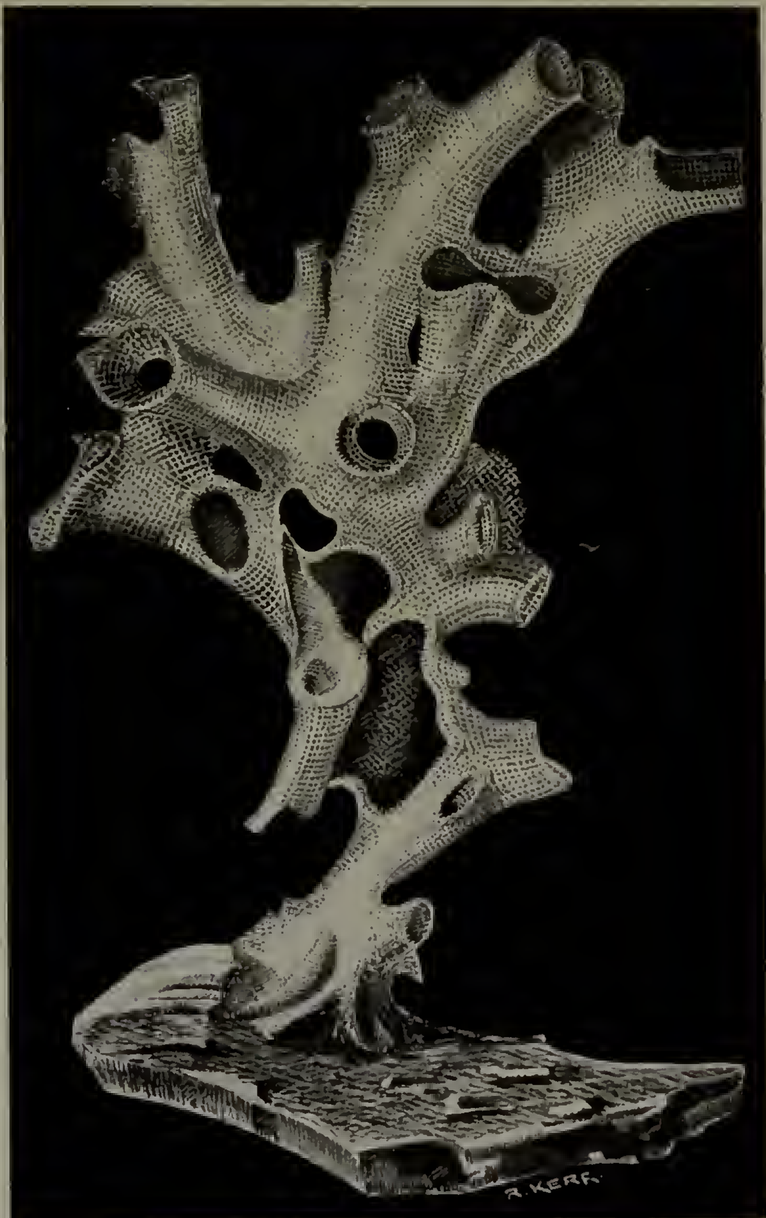

Fig. 44. Glass-Sponge (*Farrea Occa*), *see p.* 172

Natural History Museum

NATURE—CURIOUS . AND BEAUTIFUL.

By

RICHARD KERR, F.G.S., F.R.A.S.

Author of 'Hidden Beauties of Nature,' etc.

A Glass-Sponge. Fig. 41. See p. 169

With Sixty-Nine Illustrations from Drawings made by the Author

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THE RELIGIOUS TRACT SOCIETY

4, BOUVERIE STREET, and 65, ST. PAUL'S CHURCHYARD

1903

FIG. 52. FOSSIL GLASS-SPONGES (*see p.* 180)

Natural History Museum

Introduction

THE following chapters have been written with a desire to attract young readers to think more of the curiosities to be found in Nature's many workshops. Wherever possible I have made my sketches direct from Nature, and for this purpose I have spent many hours in the Natural History Museum, Cromwell Road. The Honourable Walter Rothschild, M.P., Ph.D., has kindly afforded me every facility for making notes and drawings, and has generously placed several of his unique specimens at my service. He has, together with Dr. Hartert and Dr. Jordan (the able curators of his matchless

museum at Tring) given me valuable information about objects new to science, for which I am deeply indebted.

A few of these chapters have appeared over my name as articles in *Helping Words*, and I am kindly permitted to use them by the proprietor of *Great Thoughts*, Thomas Smith, Esq., to whom I am very grateful. I also thankfully acknowledge the kind permission of Mr. Henry Sotheran to copy the Tailor-bird's nest from Gould's great work.

Students in training colleges who have to deliver criticism lectures may find many of the topics of service to them. The list of curious things dealt with in these pages includes representatives of the animal, vegetable, and mineral kingdoms. If the objects themselves in some instances should not appear to be curious, there is sure to be found some particular fact connected with them that warrants their appearance in these chapters. Wherever portions of this little work have been given as lantern lectures, they have been well received by large audiences. Remembering that most young people like to obtain information on matters of science in as easy and as pleasant a manner as possible, I have tried to convey the descriptions in simple language. There has been no resort to exaggeration. From the naturalist's standpoint Nature is so grand and so wonderful in every department, in every individual member, in

every unit, whether animal, plant, or mineral, that exaggeration is quite unnecessary.

If we wish our young people to be familiar with the wonders of creation, our descriptions of Nature should be truthful. Let them have facts to deal with. There is nothing in the study of Nature that will do them anything but lasting good.

It will be understood that wherever I have used the word 'Nature' in its grander sense, I mean it to refer to the works of the Creator.

> 'He only is the Maker
> Of all things near and far ;
> He paints the wayside flower,
> He lights the evening star.'

R. K.

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CHAPTER I

The Monkey's Dinner-Bell and The Lace-Plant

WE are accustomed to noisy outbursts when we are in the neighbourhood of certain juvenile representatives of the animal kingdom. Such outbursts we attribute to 'animal spirits'—and, unfortunately, we know too frequently many noisy results to proceed from the use of 'vegetable spirits,' or spirits extracted from certain plants; but in England we are wholly unprepared for noisy and obstreperous conduct on the part of the plants themselves.

The English trees and their allies behave themselves in a becoming manner. To the English people they are models of steady, decorous conduct.

This exemplary behaviour, which is the general rule in the home countries, leads one to the deceptive idea that the trees of other parts of the world are endowed with the same self-respect. But this is far from being the case.

Certain trees of the West Indies and of the

tropical parts of South America instead of being circumspect, at certain seasons of the year seem to revel in playing pranks not only upon the natives, but also upon the monkeys that honour them with denizenship.

When trees are given to frivolity an allowance must be made for the comic antics of the monkeys of the New World.

It will be seen from the following that some idea of the natural laws prevailing among certain species of trees in the west may be obtained without journeying across the Atlantic.

A few winters ago a gentleman received a consignment of vegetable curiosities from a relative in British Guiana. Among the number was a sand-box nut, botanically known as *Hura crepitans.*

Not a word was said about the proclivities of these nuts. Perhaps it was just as well. It may have been better for his education that he was left in ignorance. The nut itself would educate him. But education ought to be a gradual process. If the nuts thought at all, they thought otherwise.

This beautiful nut specimen, with fourteen compartments comprising its periphery, and with radiations forming an excellent design in geometry, was placed under a glass shade on the mantelpiece. It was frequently taken out, handled, admired, and its

fourteen kernels rattled. It was then replaced side by side with other ornaments.

The owner was proud of his possession, for no one else in the town had one. The local museum authorities could not boast of a single specimen.

I commend the curator for his respect for his glass cases, and for his care of the eyes of his clients.

For several months the nut was in high favour and was prized beyond most of the specimens in the collection of curios. There was no need, however, to prize it, for it had a peculiar way of prizing itself.

It was a harmless custom of the possessor to go round each night to fasten the windows and doors, and to see that everything was safe.

One night, while he was thus occupied, without any warning whatever, a loud report, quite up to that of any pistol, startled the whole house. He naturally thought he had been fired at through the window, and this surmise gained support owing to the shower of broken glass that followed the report.

The window was not broken, but the glass case was gone from the mantelpiece, and alas! the beautiful sand-box nut was gone as well.

He found the fourteen kernels and the various pieces that made up the lovely device, but 'not all the king's horses, nor all the king's men' could build up the box-nut as it was, again (fig. 1).

At first the owner was sorry for his loss, but he had gained information. The experience opened up in a moment the why and the wherefore of this startling explosion.

He could get more box-nuts from Guiana, and he resolved to take good care to prevent their apparent suicide.

Fig. 1. The Monkey's Dinner-Bell (*Hura Crepitans*)

It appears that the explosion is necessary for the protection of the trees.

Owing to this effort the kernels are scattered several yards away, and do not fall immediately under the trees, as would be the case if the pods opened gradually.

It requires no great stretch of imagination to see that if the seeds fell under the tree they would take root in the decayed tropical vegetation, would grow up, and would ultimately impoverish the parent tree. This, in time, would tend to the degeneracy of the species.

A general, who has spent several years in Jamaica,

informs me that one of these trees, growing immediately in front of his quarters, was the source of some lively scenes during the ripening season.

Repeatedly were the fragments of the exploded nuts sent in through the windows.

The monkeys in the branches of *Hura crepitans* never seem to become reconciled to these explosions, for as soon as a report takes place they scamper away to the other side of the tree, only to be met with more reports and consequent terror. For this reason the nuts are called 'The Monkey's Dinner-Bell.'

If these trees could be influenced to grow in England it might be an advantage to the farmers. One or two trees in a field would produce sufficient nuts to act as scarecrows.

It is worth notice that under favourable conditions all the compartments of each nut explode simultaneously. This arises from the equal drying up and contraction of the layers of the cell walls.

Sometimes the fragments and kernels are scattered to a distance of fifteen or sixteen yards away from the outermost limits of the tree.

In the largest of the museums in Kew Gardens the curator is well aware of the love of liberty inherent in the box-nut. One bottleful of specimens is preserved in a solution, thus preventing the drying and contracting process. Close by is a glass jar

containing dried specimens. These can scarcely burst asunder, because several strands of stout copper wire have been passed around the circumference, and several times across the nut.

We can form some idea of the pent-up force in each little nut when we see them bound with copper wire sufficiently strong to bind a man to a post.

With patience and care it is possible to remove all the kernels and to fill in all the cavities with lead. In this form they are used as paper weights.

Hura crepitans is a branching tree that attains to a height of forty feet. It is often planted in the neighbourhood of houses, notwithstanding its surprising powers. This is owing to the abundance of its glossy, poplar-like leaves, which afford a splendid protection from the rays of a tropical sun.

'Some of the violets explode, so do members of the balsam family, and a cress as well as a spurge. One plant allied to the mistletoe is able to throw its seeds right on to another tree. The squirting cucumber, if touched by an unwary person, is apt to discharge the contents right in the face. None of these, however, proceeds with such vigour and regularity of division as "The Monkey's Dinner-Bell." When we think of the hurry and decision with which the *Hura* gets rid of its offspring, we fall into a spirit of "philosophy," and wonder how

it is that the cocoanut palm not only provides its seeds with an almost impenetrable covering, but drops them gently at its very own feet. This instance is exactly the opposite of the one already quoted, and affords a good example of the diverse plans and methods of nature.' [1]

The *Lecythus* and *Anagallis* also explode in order to liberate their clusters of seeds.

The Lace-Plant

There comes to every one who really loves nature a feeling of almost ecstatic delight when he sees for the first time one of her attractive products.

The lace-plant is one of these products which give rise in a very marked degree to these pleasant sensations. A piece of bark is stripped off the branch, one end is opened out and opened out until you wonder how many more foliations are coming. You arrive at a stage when you find you have a layer or layers as thin as a sheet of note-paper; but it is still capable of division until it approaches the texture of very fine muslin (fig. 2).

The thin piece of bark can be separated into twenty or more layers, and then you have a light object that would do well for dusting furniture, but it would be a sacrilegious act to turn it to such a degrading purpose. It deserves a place with your

[1] *Current Literature*, New York, commenting on this article.

most costly treasures, although its price in Jamaica was less than sixpence.

The native women of the island are expert in

FIG. 2. THE LACE-PLANT (*Lagetta lintearia*)

carrying the opening process a step or two farther. They take out strand after strand of the fibre and dexterously work them into various articles for wear and for household ornamentation (fig. 3). The spinning of the thread that is necessary in other

branches of lace manufacture is not required here, for nature produces the thread ready for use when once it is taken out from its fellow threads that conjointly make up the bark.

This lace-plant, to which botanists have given the name *Lagetta lintearia*, as we have seen, is covered with a bark that consists of concentric layers of fibres which interlace so wonderfully, that without any great effort each layer comes off like a piece of lace from a number of pieces of lace pressed together, as it were. It facilitates the removal of the thin foliations to soak the bark in water.

There is authority for saying that King Charles II. received as a present from the Governor of Jamaica a cravat, a frill, and a pair of ruffles made by the natives, of this material ; and, to this day, it is made into nets for the hair, caps, bonnets, veils, collars, and other articles of apparel. In fact, samples of several of these articles may be seen in the largest of the Kew museums.

It must not be imagined that the lace-bark fibre is delicate and fragile, for it really possesses great strength, and is more durable than several fabrics produced from spun thread. Sloane says that complete dresses for ladies have been made from this very bark, and that Lagetta cloth has been imported into this country under the name of Guana.

Of course, the number of laminæ into which the bark is capable of division depends on the age of the tree, probably each foliation corresponds with a single year's growth.

Fig. 2. The Lace-Plant. Native Work, Jamaica

With ordinary care all the manufactured products we have enumerated may be washed and bleached.

Unfortunately there was a time when this natural lace was turned to an ignoble purpose. It was

used in the manufacture of thongs for whips, with which the negroes were beaten by their cruel taskmasters.

In England the lace-plant is often cultivated as an object of interest and curiosity. We must not leave the subject at this point without a few particulars as to its botanical qualifications. It is a small tree of the Spurge Laurel kind. The name given to the family is not much of an improvement upon any of the other names in favour with botanists —viz., the *Thymelæaceæ.* It is known by its 'perfect flowers,' so we are told. For my part, I thought all flowers were perfect, for even Solomon in all his glory was not arrayed like one of them. It has a tubular perianth beautifully coloured, eight stamens, and a small, round, hairy fruit enclosed in the persistent base of the perianth. It grows on limestone rocks, and inserts its roots into the fissures. It has broad, rounded leaves, and its flowers are like those of the lily-of-the-valley.

This property of splitting up into leaves, resembling the leaves of a book, is not confined to the lace-bark, *Lagetta.* Quite a large number of trees produce bark which can be made into clothing. In tropical countries the natives frequently take advantage of this, and produce materials that have all the appearance of having passed through the loom.

Nowadays several kinds of bark are made into

ropes, paper, etc. Any museum with a fair collection representing economic botany is bound to have specimens of bark used in such manufactures.

Beautiful lace work has been made by Irish women from the fibres of the nettle and of the convolvulus. But this opens up a wide domain of trees and small plants, cocoanuts, the flax-plant, and a host of other members of the vegetable kingdom, which by their fibres, husks, pods, or even their stems, contribute to man's comfort by supplying the raw materials in a lavish and yet mysterious manner for the purposes of manufacture.

Among the strikingly beautiful things of the earth must be classed in a very prominent position the bark of the lace-plant, *Lagetta lintearia*.

CHAPTER II

The Teasel or Teazel (*Dipsacus*), The Pitcher-Plant, and Venus's Fly-Trap

THE teazel can perform a duty which no machine, however delicate or accurate, can do half so well. The genius of the nineteenth century produced appliances innumerable and wonderful, both in time and labour-saving; but, so far, the teazel defies imitation and is incomparably superior to any machinery, whether English, German, or American. No machine has yet been invented to supplant it. If any man can make artificial teazels, having the same elasticity, flexibility, and other qualities as the fruit-heads of this plant and at a trifling cost, he can win a name and a fortune.

The dried, thorny fruit-heads of the teazel are in demand wherever cloth is manufactured. It is apparent therefore that enormous numbers are required. Many millions of them are used annually in England alone. The demand is so great that

over twenty million teazel-heads have to be imported from the south of Europe, France, and Germany, to supplement those grown in the West of England.

In the factories the teazel-heads are methodically arranged upon cylinders which revolve over the cloth so that the hooks of the teazels come in contact with the cloth and raise a nap which is subsequently cut level.

Wire cards and various other toothed contrivances have been tried, but they are more or less unyielding when the slightest obstruction occurs in the cloth, and a rent is the result.

The teazel is more yielding and, if it could bring reasoning powers into play, we should say it is more considerate, and rather than wound the susceptibilities of the beautiful material it sacrifices one of its awns or hooks so that the cloth should not be torn. Self-sacrifice, if not always appreciated, has in the case of the teazel a high commercial value. It will be no easy task for man to make a machine, however automatic, that will be endowed with this additional quality of self-abnegation.

When the purple flowers wither, the heads with portions of the stems attached are dried and assorted into sizes to suit customers. According to their quality and sizes, they are known as 'kings,' 'queens,' 'buttons,' etc.

The teazel grows in the south and west of England

by the hedge-rows and on waste ground. The plant requires two years for perfect growth. Its whole surface is covered with prickles. The leaves grow in pairs, and are so united at their bases as to form a deep receptacle for holding water. It was owing to this cup-like structure that it was considered a

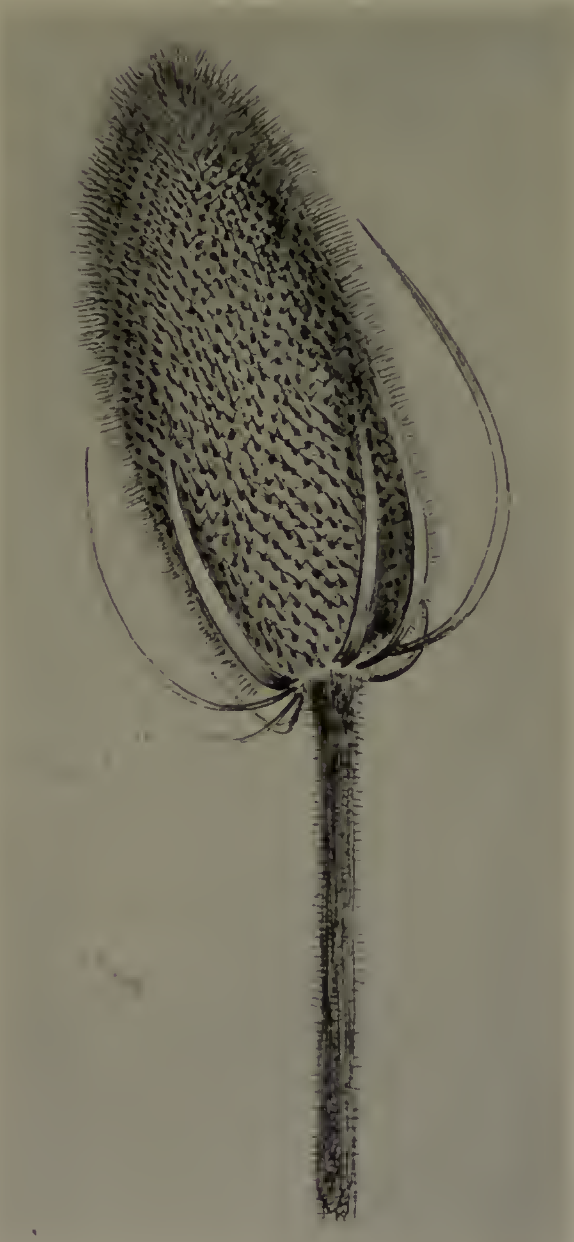

FIG. 4. THE TEAZEL (*Dipsacus*

thirsty plant. Hence its generic name, *Dipsacus*, from a Greek word signifying to be thirsty.

The *Dipsacus fullonum*, the Fuller's Teazel, is thought by botanists to be a variety of *D. sylvestris*, the Common Teazel, which grows in the south of England, Ireland, Central and South Europe, and parts of Asia. And the only apparent difference from *D. sylvestris* lies in the fact that the scales or thorns of the fruit-heads of *D. fullonum* are hooked instead of straight.

The teazel reminds us that we must not despise the unattractive in nature. There is hardly a plant more uninviting. Leaves, stems, and fruit-heads are all covered with sharp thorns, like so many fixed bayonets which appear to mean both defence and defiance; yet, in its usefulness to the manufacturer and consequently to almost everybody, for most of us require cloth, it stands unrivalled.

The Pitcher-Plant

The insect-catching plants are among the most wonderful representatives of the vegetable kingdom. They are not by any means limited to the use of pitchers in their modes of capturing insects. The *Dionæa* and the *Drosera* have no pitchers.

There are at least thirty species of *Nepenthes*, all of which have pitchers. Each pitcher has a lid, but the function of the lid is not to act like a trap by

FIG. 5. THE PITCHER-PLANT (*Nepenthes khasiana*)

falling over the mouth of the pitcher. It acts as an attractive surface, both by its colour and its honey secretion. The lip is covered with large glands which also secrete honey, so that insects are led from the lid to the lip. The lip is curved inwards at the edge and downwards, thus preventing the return of any insect that enters the pitcher. The inner surface of the pitcher below the lip is slippery, and in some pitchers, as that of the *Sarracenia*, it is covered with hairs pointing downwards, presenting an impassable barrier to any insect's return (fig. 5).

A digestive fluid is always present in the pitcher. It is a secretion from the glands of the inner surface, and contains a gastric ferment analogous to that of the members of the animal kingdom. The plant thus captures insects, and digests and assimilates them. Analyses of this liquid and of that of the stomach of the animal show no appreciable difference. On this question of digestion a line of demarcation cannot be drawn between the animal and the plant, but it rather serves as a bridge connecting the two kingdoms.

The question naturally arises, in what manner does the accumulation of putrid matter arising from the dead bodies of insects arrive at the roots for nutritive purposes? I believe it was Lord Avebury who found in the *Dionæa* of North Carolina and in other plants, a channel leading directly from the

leaf to a point over the roots, along which the products of digestion pass ; and that this same great authority was further rewarded in his researches with the Pitcher-Plant, *Sarracenia*, to which I have just referred, in discovering the actual constructor of this remarkable channel.

Large numbers of flies are drowned in these pitchers, and form a putrescent mass, in which the grub of an insect finds abundant food for itself while it is furthering the digestive processes of the plant. The grub in time is ready for changing into the pupa stage, and sets about boring a hole through the plant, along which it is to escape to the earth. This channel remains, and whenever it rains, the accumulated products in the pitcher become sufficiently liquid to pass along it and on to the roots. It is worth noting that the insect makes the passage just before the flowering time of the plant arrives, when the plant most needs nourishment.

It is evident that the duty of the pitchers is to supply extra nourishment for the growth of the flower and fruit. In tropical climates they also help to reduce the number of insects.

Venus's Fly-Trap

A plant which the great Charles Darwin says 'is one of the most wonderful in the world' must be well worthy of our notice. Unfortunately it is

not easy to obtain specimens for observation, as its home is limited, so far as we know, to the eastern part of North Carolina. But Canby in America, and Hooker, Darwin, Lord Avebury, and Burdon Sanderson in England, have given a great deal of time and attention to the study of this plant—with exhaustive experiments—and they have placed within our reach a vast amount of information about the *Dionæa*, all of which is intensely interesting and invaluable. One can hardly imagine that such a tiny plant should absorb the special attention of such great and learned authorities. Therefore while appreciating their work, we ought to learn the main particulars, at least, of this important member of the vegetable kingdom. 'The rapidity and force of its movements' place it in its unique position among other plants.

In the case of the *Drosera*, the captured insect, in the first instance, is held by a glutinous secretion and is gradually embraced by the tentacles or arms of the plant. But the behaviour of the *Dionæa* contrasts with this, in that its movements are more like that of a rat-trap (fig. 6). At the end of each footstalk there is a two-lobed leaf, the lobes standing at rather less than a right angle to each other. It is between these lobes that the insects are captured. The edges of the lobes are prolonged into spines. 'Three minute, pointed processes or filaments, placed

triangularly, are projected from the upper surfaces of both lobes.' These have been proved to be sensitive points, contact with which causes the lobes to close rapidly. These little pointed processes stand in such a position that, when the lobes close, they interlock. 'The upper surface of the leaf is

FIG. 6. VENUS'S FLY-TRAP (*Dionæa muscipula*)

thickly covered, excepting towards the margins, with minute glands of a reddish or purplish colour, the rest of the leaf being green. They secrete, but only when excited by the absorption of certain matters.'

When an insect touches the sensitive hairs, the lobes press quickly and closely together, the glands

are brought into contact with the insect, and secretion commences. This secretion is acid, and contains a digestive ferment. The leaves remain closely shut for many days, and after expanding again are torpid. The power of digestion is limited ; the leaves cannot digest more than two or three times in their life.

'*Dionæa* is looked upon as the most highly specialised of Insectivorous Plants, its sensitive hairs serving as organs of touch, its lobes for capture, and its glands for the consumption of its prey, while in the *Drosera* the tentacles effect all these ends.'

The illustration is taken from the excellent model in the Botanical Department of the Natural History Museum, while most of the foregoing details are from the descriptive label attached, and from Darwin's great work, *Insectivorous Plants.*

The plant was first described by Ellis in 1768, in a remarkable letter to Linnæus, and Linnæus declares the *Dionæa muscipula* to be the most wonderful of plants (*miraculum naturæ*).

CHAPTER III

The Hop-Plant, Schubertia, and Riella

THERE are several curious and interesting particulars connected with the hop-plant which are well worth mentioning. Nature has not provided all plants with thick, rigid stems capable of giving them sufficient support to stand alone in the battle of life. A great number of them, not having inherent strength to be independent, require external support, and are known as *climbing plants.*

In dense forests and jungles plants with weak stems would fare badly as regards sunshine, were it not that they are endowed with special facilities for attaining to great heights. This is accomplished, too, by the expenditure of very little in the way of material and in a variety of ways.

Some are *twining* plants. The whole of the plant twines round the supporting agent. One of the most graceful of all twining plants is the Hop. This plant in climbing round its support takes the

same direction as the hands of a clock—describing a right-handed helix. It is provided with longitudinal rows of tiny hooks, which give support to the plant. These hooks render a great service, because, as the foliage increases and hop-heads appear, the upper parts of the plant become heavy, so that something more than the delicate stem is required to enable the plant to reach the sunshine, and to attain to its full maturity and prolific condition. The important function, therefore, of these little hooks becomes apparent.

In the illustration an enlarged section of hop-stem containing hooks is shown, and two of the hooks are still further enlarged.

The growth movement of a climbing plant is called its nutation. Wherever the plant or its tendril touches the object on which it is climbing the stimulus of contact causes the side away from the object to grow more rapidly than the other, and in this way the plant or its tendril commences to curve round its support. It appears from this that plants are sensitive to continued contact, and that they move in response to such stimulus. This constantly brings new surfaces into contact, and causes the twining of the plant or of its tendril. We cannot fail to notice at this point how very closely the plants approach by their sensitiveness the members of the animal kingdom. The sense

of touch seems to be very much of the same nature in both kingdoms (fig. 7).

FIG. 7. THE HOP-PLANT (*Humulus lupulus*)
Natural History Museum

But to return to the hop. The hop has a perennial root and annual stems. The male and

female flowers are generally on separate plants. The male flowers are in loose tufts, but those of the female are in dense catkins with membranous, irregularly developed leaves or bracts. The hops of commerce consist of the female flowers and seeds. Numerous little, yellow, shining, resinous grains are to be seen on the bracts, which give out an aromatic odour. They are known as lupulinic glands, and are believed to be the most active parts of the hops.

The hop possesses both tonic and hypnotic properties (that is, power of inducing sleep). Pillows stuffed with hops are sometimes used with success in cases of sleeplessness. From the brewer's point of view the plant possesses several qualities which make it valuable to him in the manufacture of beer. First, in malt liquors, hops exert a chemical influence that preserves them from turning sour by checking acetous fermentation. This quality renders the beer capable of being kept. Secondly, the tannin of the hops by precipitating the albumen of the barley clarifies the beer. Thirdly, they give an aromatic flavour to the beer. Then, fourthly, comes in the question of *headiness*. Owing to this property the brewer need not use so much of his malt. But apart from the purposes of brewing, hops are often prescribed as a tonic. John Gerarde, a botanist, surgeon, and quaint

writer of Queen Elizabeth's reign, says of this plant :—

'The hop joyeth in a fat and fruitfull ground, also it groweth amongst briers and thornes about the borders of fields. The flowers are used to season beere or ale with, and too many do cause bitternesse thereof, and are ill for the head. The manifold vertues of hops do manifest argue the wholesomenesse of beere, for the hops rather make it a physicall drink to keep the body in health, than an ordinary drink for the quenching of our thirst.'

We are not all likely to accept his statement that hops make the beer 'a physicall drinke to keep the body in health,' but we must agree with him that 'too many do cause bitternesse thereof, and are ill for the head.'

In the time of the Romans the hop was a garden plant, and the young shoots were eaten as we eat asparagus. It was first used in England for brewing purposes in the reign of Henry VIII. Its introduction quite supplanted the use of the tender shoots of the broom that were used to give the bitterness so much desired.

In the third year from the date of planting, the hop-plants grown from root sets come to perfection. The young shoots appear towards the end of April, and the plants are in full bloom and ready for

picking towards the end of August. The hops are spread out in the oast houses, and dried on a strong hempen or hair network, which allows the free passage of hot air. The process of drying takes from twelve to twenty-four hours. When dried they are placed in the stove-room, where they are fumigated with the fumes of flowers of sulphur. They are then ready for packing in bales. This is accomplished by a screw-press.

The English crop varies with the acreage under culture, which ranges from 50,000 to 70,000 acres. The average yield is from five to ten cwt. per acre. The import from America and the Continent amounts to an annual average of 200,000 cwt. The hop requires a very rich soil that contains plenty of organic and mineral dressings.

The principal hop localities are Kent, Surrey, Sussex, Worcestershire, and Herefordshire. The hops grown in the Vale of the Severn are very fine.

The hop crop is a risky one for the farmers, owing to the many obstacles that militate against it from the time it is planted until it is placed on the market. But should one crop in three prove successful, the farmer will be recouped for all his trouble and loss.

Hop-poles varying in height from ten to twenty feet are used for supporting the hops. When the

hops are ready for picking, the stems are cut through about a yard from the ground, and the poles are pulled up so that the hops may be readily picked off by hand.

In F. E. Hulme's beautiful work, *Art Studies from Nature*, he chooses the hop-plant for a wonderfully graceful design, set in two overlapping equilateral triangles, in which he makes a number of hop-heads fit into three angles, alternately with hop-leaves occupying the three angles between. For purposes of ornamentation, either in wood, stone, or plaster, its adaptability is all that could be desired. He mentions that the capitals of Southwell Minster afford a practical example of what may be done in this direction.

With regard to the way in which a plant climbs around a support, we say the hop twines in the direction taken by the hands of a watch, and the convolvulus twines in an opposite direction. These statements are not so convincing as they may appear at first sight. What right and left twining means often gives rise to a great deal of argument. But the matter can be easily settled in the following manner: Place a watch on its back on the table, then put a walking-stick standing upright also on the table. Begin at the lower end to twine a piece of cord round the stick in the same direction as that taken by the hands of

the watch. The cord will exactly represent the twining of the hop.

Schubertia grandiflora

The original home of this remarkable plant is Central America. It thrives, however, in our own country. It is a climbing plant and may be purchased for a few pence at any of the large nurseries. Its lovely white blossoms appear in July, and they depend so gracefully on their stalks that they remind one of Mr. Brock's splendid rockets bursting above the Crystal Palace grounds. Every person who examines the details of the flower expresses astonishment as they are unfolded (fig. 8).

The plant from which the illustrations were made is nearly four feet high, and its long twining stalk is covered with very fine hairs. Its white blossoms are quite two inches in diameter, and are frequently mistaken for those of the Syringa. They yield a delicious perfume. But to come to the point of greatest interest for my purpose and one which might be looked upon as trivial and superficial by the learned botanist : Take a blossom and remove the five petals that form the corolla, and you will now have a bulb-shaped calyx attached to its stalk. Proceed to fold back each sepal, and, on looking straight down upon the inner portion, a regular five-sided device appears with a raised centre, having

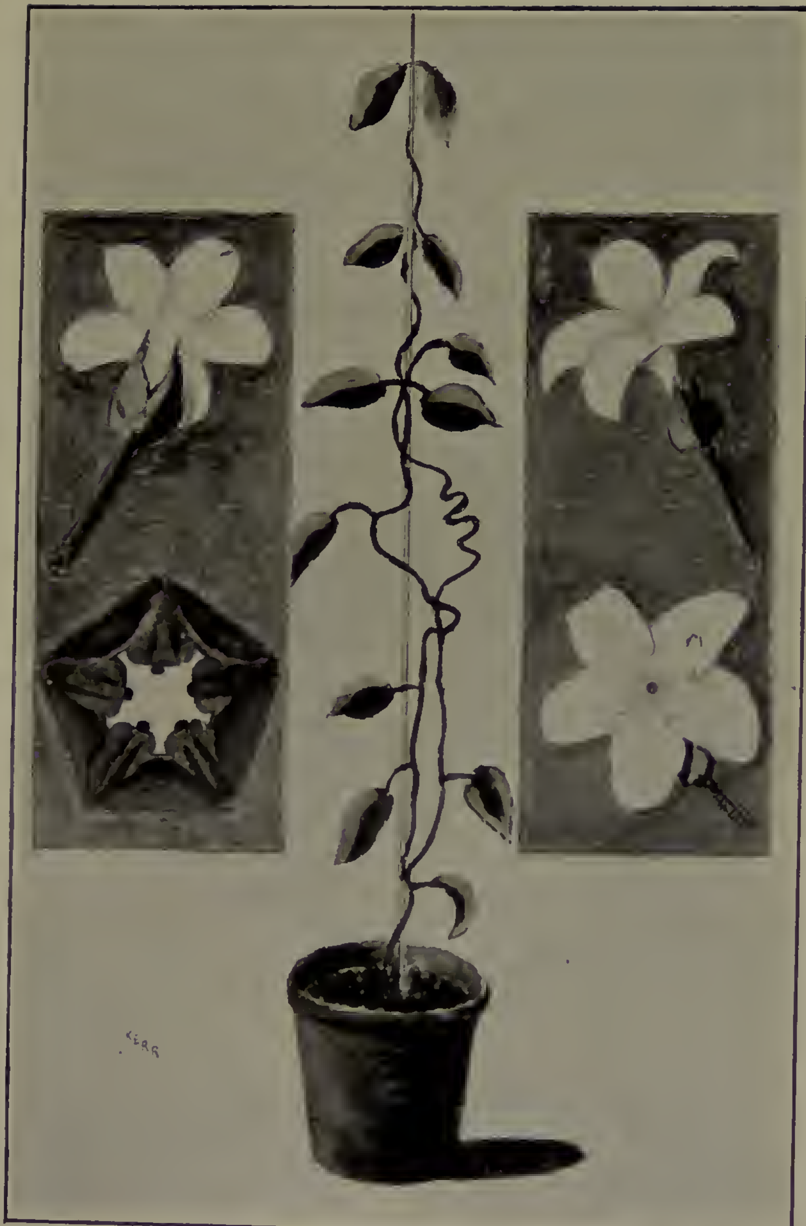

Fig. 8. Schubertia grandiflora

a close resemblance to a tiny ball of ivory not quite so large as a pea. To use an architect's phrase, we have so far been examining the *plan*. Let us look at its *elevation*. Hold it up and look at each corner of the pentagon, and at once the exact counterpart of the features of a venerable gentleman will be seen. Rotate it, and five similar faces will appear, the left eye of one face acting also as right eye for the next face (fig. 9). The illustration may be considered an imaginary sketch grossly exaggerated. But this is not so. Exaggeration is out of the question and is altogether unnecessary and superfluous. The top of the head is as smooth as the proverbial billiard ball, the forehead is wrinkled, the eyebrows are projecting, the eyes piercing from their sunken orbits, the nose prominent, the cheeks receding and lined, the long white beard is perfect, and the proportions of the head are apparently correct.

'Wonderful!' 'lifelike!' and 'startling!' are some of the exclamations of those who see this object for the first time.

The form of the human face is fairly well shown on the carapace of the 'mask' crab and on other objects in nature, but this is not merely a case of one or two points of resemblance to a human head. It has all the appearance of a head proportionally reduced to very small dimensions.

Some one may say: 'Explain the reason for all this.' This is too much to expect. It is easier to ask questions about nature than to answer them.

Fig. 9. Schubertia grandiflora

The aim in view in putting together brief descriptions of a series of curious products of nature is to draw attention to them and to cause an interest to be taken in them, in the hope that young people may

see that nature is stranger than fiction, and that they may find in nature ample material for absorbing research.

Riella

The Riella is a graceful little water plant, spiral in form, and only two inches long. It is one of the mosses. The mosses are not generally looked upon as yielding any particular benefit to man. One writer says: 'They perhaps yield fewer objects of utility to man than any other division of plants, except those of the same alliance. In agriculture and in the garden, though of small size, they are often noxious weeds.'

This is rather a sweeping statement, although made in *The Treasury of Botany*.

Surely the mosses make the landscape more beautiful, by affording a rich covering for old ruins and walls and trunks of trees. And do they not add largely to the material required for the formation of peat, and cannot peat be used in more than a hundred serviceable ways? Do they not collect and hold water in large quantities? This is to me a striking point in their favour, especially in warm climates. They seem to fulfil an unusually important office in the economy of nature. Mosses are to be found in all parts of the world, even on mountains, at heights where all other vegetation

ceases, and in the depth of the forest where vegetation is most prolific. One of their functions is to collect the rainfall like so many sponges, and as they form a thick covering on the trees, they retain for them that moisture which would otherwise rush away in torrents.

Then again the disintegration of many rocks and the consequent formation of humus, or

FIG. 10. THE RIELLA

mould, is brought about by the action of mosses. The seeds of the higher plants by taking root in this congenial mould are thereby indebted to the despised mosses.

To the microscopist the mosses are always attractive for their marvellous structure and beauty.

The Riella, although one of the mosses, is classed low down among the Liverworts (fig. 10). In most liverworts the plant has a definite leafy structure, but in the Riella we have an exception, which is the main cause of its appearance in these pages. Instead of leaves, it is endowed with a beautiful membranous wing about the fifth of an inch wide. This wing is of a pure green colour and of extreme delicacy. It turns spirally on a central axis, forming a winding screw, and reminding one of the staircase up the tower of Exeter Cathedral. The central pillar in the staircase corresponds to the ribs or axis of the water-plant. As the membranous wing turns round it has the form of a cone inverted. Although the plant is only two inches high it is looked upon as one of the most remarkable in the whole of the vegetable kingdom.

All the mosses, with this single exception, grow horizontally, but the Riella grows upright, and is one of the few that grow in water. In fact, it comes to perfection completely under water.

It is attached to the ground by clasping roots known as rhizoids.

A distinguished soldier and botanist, Durieu de Maissoneuve, was the first to discover and describe this plant. He found it in Algiers.

The shape assumed by the plant is what is termed a right-handed helix. There are many instances of the spiral in Nature, some of which are noticed in other chapters.

CHAPTER IV

The Leaf-Butterfly, The Caterpillar-Fungus, and Bark-Borers

OF this insect Mr. Alfred Russel Wallace, the great authority on many departments of Natural History, says :

'By far the most singular and most perfect disguise I have ever met with in a Lepidopterous insect is that of a common Indian butterfly, *Kallima inachis*, and its Malayan ally, *Kallima paralekta*.'

One feels sorry for those persons who have never seen this creature. Londoners and residents in other large cities have no excuse for missing this and similar surprises, for no natural history museum is complete without *Kallima*.

Many visitors to our great London museum, to use an Irishism, look at these very insects and yet do not see them. They never realise that they are insects, so that they miss every point of their wonderful structure, and the reasons why they are so very attractive to any one who takes an interest

in mimicry in nature. But I am not in a position to blame such people, for only recently an oak branch was placed in my hand for my examination and opinion, but I saw nothing remarkable about it,

Fig. 11. Caterpillars of the 'Oak Beauty'

and said so. On looking more closely I found that four of the apparent branches were caterpillars mimicking the branches. They were rigid, motionless, coloured exactly, even to the sheen of the new

oak bark, and knotted. A wonderful instance of protective mimicry! The insect is the moth found on our own trees—'The Oak Beauty' (*Amphydasis prodromaria*, see fig. 11).

But to return to the *Kallima*, the following are some of the salient points of resemblance between the insect and the dead leaf:—

(1) The general shape of the insect when its wings are folded is that of a leaf.

(2) Each wing has a slightly curved dark brown line traversing the middle of its whole length, which corresponds to the midrib of the leaf.

(3) There are transverse lines crossing the wing, which appear like the veins in the leaf.

(4) When closed, the hind wings terminate in a little tail, which resembles the stalk of the leaf.

(5) This 'tail' is always curved inwards a little. The reason for this will be shown presently.

(6) The underneath side of the wing resembles in colour that of a dead leaf.

(7) As dead leaves often have blotches of lichen or fungoid growths on them, black, brown, or white, so it is with the wing to all appearances. And what is very striking is the fact that one rarely ever finds the undersides of any two wings identical, in either the colour or the mimicking patches. There are eight specimens in this room as I write, and while the upper surfaces of all the wings agree in colour,

FIG. 12. THE LEAF-BUTTERFLY (*Kallima*)
The Rothschild Museum

all the under surfaces are different from each other.

As Mr. Wallace points out, if they resemble dead leaves for protection from birds, they would become conspicuous on a branch of green leaves, but strange to say they invariably alight on those branches that have dead leaves, and are instantly lost to sight, owing to the close resemblance to all the surrounding leaves (fig. 12). The change from a gorgeous butterfly flitting in the sunshine to the garb of a dead leaf is almost instantaneous. Many a time has this great naturalist been completely baffled in trying to locate them.

He notices another point which completes a wonderful parallelism. The insect prefers to rest on vertical or nearly vertical branches, and as the little tail to which we have referred (4), (5), is slightly curved, it touches the branch and looks as if it were attached to it! If the tail were quite straight, it would hang clear of the branch, and thus fail to represent an attached leaf.

The Caterpillar-Fungus

Whatever may be described in these pages as curious or remarkable there will be nothing more curious than the caterpillar-fungus.

The name implies a kind of dual organism—an animal and a vegetable. There is the caterpillar,

and there is the fungus. So great a puzzle is it to naturalists that some writers reverse the above title somewhat, by calling it 'The Vegetable Caterpillar,' others 'The Ensign Caterpillar,' and so on. In an American magazine of very prominent position a glaring mistake is made where these caterpillars are figured as if above ground carrying the tall fungoid growths on their heads like so many ensigns of death. This, as we shall see, is an utter impossibility.

The caterpillar, whether of *Cordyceps gunnii* or *robertsii*, makes a more or less vertical hole in the ground, cylindrical in shape. This varies from four inches to a foot, or even to two feet, in length. At times the direction of the burrow runs at right angles to the vertical passage. The creature evidently resorts to this device in order to find certain roots for which it has a special liking. Throughout the passage is lined with a coarse web which enables the caterpillar to move with freedom. If unmolested, it undergoes one stage of its metamorphosis in this burrow.

But once in a way a caterpillar has the misfortune to allow a fungus germ to find a resting-place in the sticky substance behind its head. Up to this unfortunate occurrence we have the caterpillar on the one hand, and the fungus spore in the air floating about. There are thus two separate organisms.

The spore of the fungus finds in the caterpillar a congenial home; it germinates, and absorbs the juices of the creature's body at the expense of the vitality of the caterpillar. Its roots gradually fill up the body cavity of the creature without injury to the general shape and texture of the skin. It is needless to say that long before this change is completed the caterpillar has ceased to exist.

When the fungus can obtain no more nutriment it, too, succumbs, for it has not the power to assimilate inorganic matter from the earth like ordinary plants—a point in which all the fungi differ from the rest of the vegetable kingdom. They require organic matter, either animal or vegetable, for their subsistence.

During its growing period it finds its way up the whole length of the passage, as its long stalk shows, and it often continues up above ground a few inches more, with a head somewhat resembling that of a bulrush, but much smaller.

Although the fungus dies it has even in death an advantage over the caterpillar, for its spores live and take root elsewhere, whereas the creature cannot attain to the perfect or imago state. It dies in the grub stage.

Of course, only a small percentage of these caterpillars incur the disease. Large numbers that are not afflicted change into chrysalides, these change

into moths, the moths lay eggs, and these are hatched into caterpillars, and so on.

At the same time many specimens of the cater-

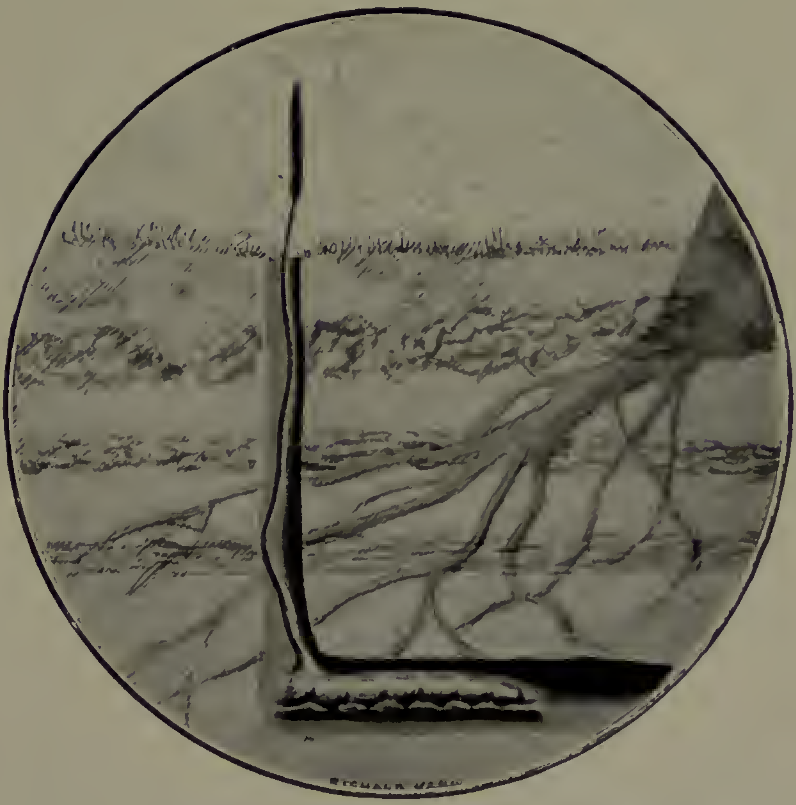

FIG. 13. THE CATERPILLAR-FUNGUS (*Cordyceps*)

pillar-fungus are found in Tasmania, Australia, and New Zealand.

The animal substance is completely replaced by vegetable, so much so, that when the specimen is

removed from the ground, it has the appearance of a wooden caterpillar with a huge horn of wood much longer than the creature's body standing up at right angles to the back of the head (fig. 13). It was owing to this appearance that many doubted the living existence of the caterpillar, and looked upon the specimen as wholly vegetable from its commencement. But this has been entirely disproved by Hooker, Berkeley, Gray and Gunn.

Around Launceston in Tasmania the caterpillar fungus is frequently found, where the vegetable intruder is known as *Cordyceps gunnii.*

Now with regard to the American illustration the accuracy of which I have doubted—caterpillars completely replaced by wood have been found varying in size from two to four inches long. This shows that at any period of the grub stage they may become the victims of the spore while they are in their burrow; and when once the plant has germinated, it is impossible for the caterpillar to come above ground. They have never been found above ground. When specimens are required, collectors must dig for them.

Instances are known where the fungus spores have even developed from the chrysalides. In such cases the fungus must have obtained lodgment in the caterpillars immediately before the change into the

chrysalid stage. Two Greek words—*entoma*, insects and *phyton*, a plant—give rise to the name *entomophytes*, as applied to these combined natural productions, or more strictly to the plants that adopt this particular mode of living upon insects.

All parts of the specimen underground are white, the part of the stem above the ground is yellow, while the velvety top is of a dark olive colour. The wonderful replacement of animal tissues by vegetable fibres is well worth the attention of botanists and entomologists alike.

In the museum at Keith there is a well-preserved specimen from New Zealand, and accompanying it is the following description, which is very interesting, in that it contains more particulars than are generally known :—

'SPHŒRIA ROBERTSIANA

'Scientific name of caterpillar : *Hepialus virescens*, which, after its chrysalis state, becomes one of the night butterflies of New Zealand. Maori name : *Pepeaweto*. Botanical name : *Sphœria robertsiana*. Maori name : *Hotete*. English name : "Vegetable caterpillar."'

It is chiefly gathered about the roots of the Rata tree (*Metrosideros robusta*), but it is also found in forests where no *rata* grows. This caterpillar, while burying itself in the ground for the purpose of

changing into the chrysalis state, gets the spores of the parasitical fungus between the head and the first ring of its body ; the spores then vegetate and take root in the interior of the caterpillar, utilising and absorbing the whole of its inside to live and thrive upon. When all the animal matter is exhausted, the fungus seeds and dies ; it throws no root out of the body of the caterpillar, but is born, lives, flourishes, and dies only on and in the caterpillar, not destroying the outer skin, but leaving that perfect though hardened into a fungoid mass, retaining perfect shape.

When first dug up they are soft, but soon harden. They are eaten by the natives, and when fresh gathered have a nutty taste. They were also used, after being charred in the fire, to colour the wounds caused in the process of tattooing.

Sizes of the caterpillar vary from one to four inches long, and the seed-stalks from three to ten inches long. It has no leaves, and the growth nearly always commences from the neck of the caterpillar. Dr. Hochsteller says, in his work on New Zealand, that he examined several hundred specimens, and only one had grown out of the aft-end of the caterpillar.

'I have one in my herbarium that is growing out at both ends, and it bears three spore heads instead of one.' There are two other varieties in

New Zealand. One called by the natives *Aweto*, is found in the Kumara beds; the other, called *Wéré*, is found in the open bush, but is very rare.'

Bark-Borers

There are several kinds of small beetles whose operations are directed to the bark of different classes of trees, and whose ravages are often so great as to do enormous damage.

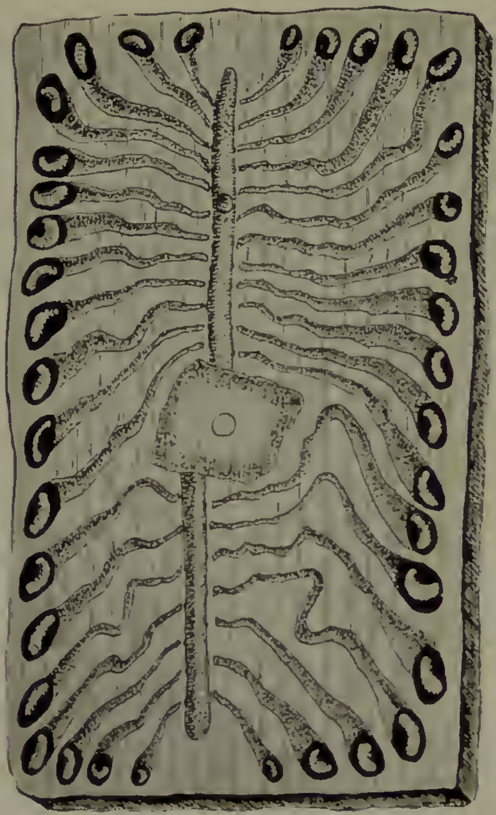

FIG. 14. THE PINE BARK-BORER
(*Tomicus typographicus*)
After H. Wettstein

In 1783 in Germany a million and a half of trees are said to have been destroyed in the Hartz Forest alone by two small species of beetles.

The larvæ burrow beneath the bark and thus cause the injury to the growing trees. The most familiar are the *Scolytidæ*, whose curiously designed

burrows in the bark of the elm are well known, and the Typographic Beetle (*Tomicus typographicus*), so called from the resemblance which its burrows, made in the soft wood immediately beneath the bark, bear to printed characters (see fig. 14).

These tiny creatures have tremendously developed jaws which move against and towards one another sideways.

Towards the end of April or the beginning of May the beetles take to the wing. A pair will select a spot on the bark of a tree and commence operations by boring a vertical hole to the inner bark; here they clear a surrounding space known as the first chamber, and from it they proceed to cut a channel upward and downwards. Sometimes several pairs will start tunnelling from this chamber. As they proceed, ventilation becomes necessary, so they bore tiny upward shafts for this purpose.

Frequently one may become aware of work going on under the bark by the falling of the brown dust, which becomes lodged on spiders' webs, moss, etc.

The channels, or 'mother galleries,' being made, the female lays its eggs on each side at intervals. The number of eggs varies between thirty and a hundred. From these, tiny grubs are developed, for the beetle undergoes a true metamorphosis.

Each little creature now starts to burrow under the bark in a direction mainly at right angles to the

'mother galleries.' It makes an enlarged space at the end and forms a kind of cocoon, undergoes another change in its life-history, and in the course of three weeks, or thereabouts, it emerges as a beetle. The whole development occupies from six to ten weeks. In one season, therefore, vast numbers of these insects are brought to life, even in one tree-trunk.

All the time they are excavating their tunnels they are devouring the sappy portions of the trunk and bark layers.

It is easy to understand how whole forests may be destroyed in a very short time.

The best remedy is to cut down any tree infected, remove it from the forest and burn it.

All sickly and otherwise damaged trees should be removed, as it is thought that the beetles prefer these for their eggs.

CHAPTER V

Flata, Ecstatosoma, and Lithinus

IMAGINE a number of foxgloves in bloom, the lower blossoms fully expanded and richly coloured, while those towards the top are unopened buds, graduated in diminishing size till the top of the spike is reached, the latter buds being green. Your surprise would be great if, when you touched the plant, all the blossoms and buds arose and flew away. Yet, something akin to this surprise must have been experienced by Dr. Gregory when travelling in East Equatorial Africa.

Nothing that I have ever read or that has been told me of marvels in Nature, has interested me more than his account of this adventure as recorded in *The Great Rift Valley*.

He was working his way near the Kibwezi river when his attention was drawn to a large, brightly coloured flower like a foxglove or a *Tinnæa*, and seeing some fluffy patches below the flower which

appeared to be a lichen, which does not grow on flower-stems, he pushed his stick through the bush to pull the flower towards him, when, to his great surprise, the flowers and buds jumped off in all directions.

He evidently enjoyed the quiet treat of seeing a brother naturalist, Mr. Watson, the missionary and botanist, similarly taken in. He says:

'There were several similar clusters close by, and when Mr. Watson came up I pointed one out to him, and asked him if he had determined to what genus it belonged. He said he had not done so, but that he had seen it before, growing in these woods. He attempted to pick it, and was as surprised as I had been at the result.

'The arrangement of the colony, with the green bud-like form at the top of the stem, and the pink flower-like insects below, looked so much like an inflorescence that it deceived both of us, although Mr. Watson is an enthusiastic botanist' (fig. 15).

The fluffy objects on the stem, which led to Dr. Gregory's touching the plant, are the larvæ of the same species.

In the Rothschild Museum at Tring I was shown both Flata and the fluffy larvæ, and was assured by the noble owner of the museum that the insects can re-arrange themselves over and over again, mimicking the blossoms for protection from birds, etc.

There are many other members of the same family which imitate lichens on the barks of trees, and it is surprising to see the brown insect resting

FIG. 15. FLATA NIGROCINCTA

After Dr. Gregory

on the brown lichen, the grey on the grey lichen, and so on.

In the Natural History Museum there are twenty examples of these Homopterous insects, of which

no two are alike in colour. They are to be seen labelled *Flatoides dealbatus*; and unless the attention be specially drawn to them they could easily escape notice, although prominently placed for observation.

In the same case there are what appear to be pieces of dead foliage rolled up. Their colour is brown, their sheen and texture those of dead leaves. It is impossible to suggest anything that would make them more like decayed or dried vegetation.

It seems a puzzle to me how any entomologist should ever be able to make them out to be anything else but dead leaves, or to have had the audacity to label them insects. Yet they are true homopterous insects—*Pyrops tenebrosus*; and they are found among the *dead leaves* of Madagascar. This is another remarkable instance in which the insect is wonderfully protected from its enemies.

The discoverer of such marvellous objects in nature deserves equal honours to those given to the discoverer of an island or of a new element.

Our surprise will not be diminished when we come to the Phasmids of Australia, of which there are many varieties. One, the *Acrophylla chronos* of Eastern Australia, resembles a twig, and is effectually concealed when resting among twigs or on the branch of a tree.

Mr. Alfred Russel Wallace's description of the stick insect will be of interest. He says:

'Others resemble pieces of stick, with all the minutiæ of knots and branches formed by insects' legs, which are stuck out rigidly and unsymmetrically. I have often been unable to distinguish between one of these insects and a real piece of stick, till I satisfied myself by touching it and found it to be alive. One species which was brought to me in Borneo was covered with delicate, semi-transparent green foliations, exactly resembling the hepaticæ which cover pieces of rotten stick in the damp forests' (*Darwinism*, p. 202).

Not having seen the particular stick-insect to which Mr. A. R. Wallace refers, as having 'knots and branches formed by the insects' legs,' I am unable to submit an illustration of it, but in fig. 16, through the kind permission of the Hon. W. Rothschild, I am submitting one from an insect (*Empusa gongyloides*) in the Tring collection, which is found in Ceylon. I may be quite wrong in calling it an 'insect,' for, except in two particulars, it seems to me to fall short of Huxley's definition of what an insect should be. It certainly has the body nearly cut into two parts (in-sect), and it has six legs, but where these are joined to the thorax, or where the thorax is separated from the abdomen, are points I must leave to the entomologist.

FIG. 16. EMPUSA GONGYLOIDES
The Rothschild Museum

When resting on decayed foliage the creature would be unrecognisable, and would in that way be well protected from its foes. The creature is about five inches long ; the colour that of a seared leaf.

The Ecstatosoma

This is another of the stick insects to be seen in the museum at Tring. The upper drawing in fig. 17 I have made from the cabinet specimen, which is about ten inches long—no mean length for an insect. It looks like a jointed cane or bamboo, and oddly enough it comes from Malacca, where knotted and jointed sticks prevail. That the insect is well protected is apparent.

It will be seen in the upper sketch that, if we omit the head, there are twelve segments, and three of these make up the thorax, to each segment of which a pair of legs is attached, one on each side of the segment. Thus we have nine remaining segments.

Now, if we turn our attention to the lower sketch, which I have made from a pen-and-ink drawing which accompanies the above-named specimen in its cabinet, we shall see, omitting the three segments of the thorax, ten remaining segments instead of nine.

The rest reads like a romance ; but as this insect has never been described in print, I am only able

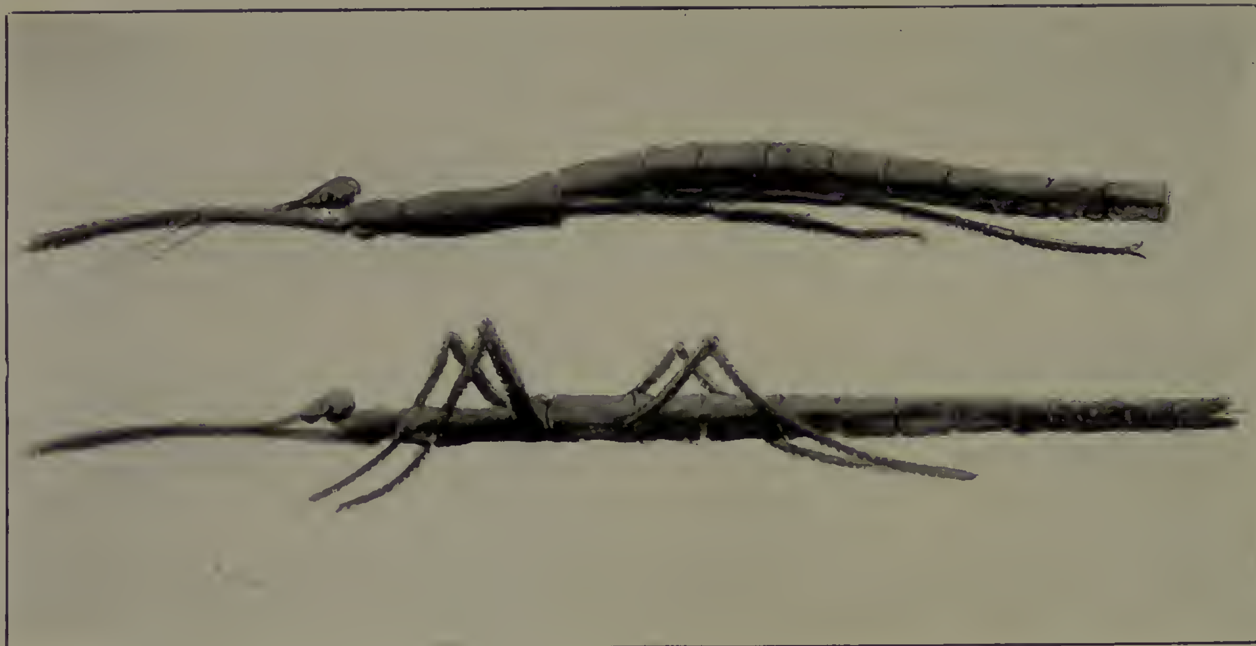

FIG. 17. STICK INSECTS (*Ecstatosoma*)
The Rothschild Museum

to submit the reported tradition about it that awaits the authority of reliable and actual observation.

It is said that when the insect is attacked by its foes, or is in danger of attack, it has the power to protrude telescopically the tenth segment, which has a mouth-like opening and a tongue-like organ which at once gives the creature the appearance of a snake. There is also a spot that answers to the appearance of an eye on the ninth segment!

But is the tradition more wonderful or more difficult of belief than the following, which I quote from one of the greatest naturalists of modern times?

Mr. A. R. Wallace, in an article headed 'Protection by Terrifying Enemies,' says:—

'A considerable number of quite defenceless insects obtain protection from some of their enemies by having acquired a resemblance to dangerous animals, or by some threatening or unusual appearance. This is obtained either by a modification of shape, of habits, of colour, or of all combined. The simplest form of this protection is the aggressive attitude of the Sphingidæ, the forepart of the body being erected so as to produce a rude resemblance to the figure of a sphinx, hence the name of the family. The protection is carried further by those species which retract the first three segments and have large ocelli on each side of the fourth segment,

thus giving to the caterpillar, when the forepart of the body is elevated, the appearance of a snake in a threatening attitude. . . . The blood-red forked tentacle thrown out of the neck of the larvæ of the genus Papilio when alarmed is, no doubt, a protection against the attacks of ichneumons, and may perhaps also frighten small birds; and the habit of turning up the tail possessed by the harmless rove-beetles (Staphylinidæ) giving the idea that they can sting has probably a similar use.'

From these observations it does not appear that the supposed powers of the Ecstatosoma are in any one particular exaggerated.

Lithinus

We are still in the Tring Museum.

There need be no question of tradition nor doubt attached to this wonderful creature. In its appearance as an instance of mimickry, it carries conviction home in as direct a manner as in any case we are considering in these pages.

In fig. 18 we see a branch or forked stick partially covered with a black-and-white lichen. Here and there are black hairs on the lichen.

The seeming patches lying about are the insects, coloured in every detail like the parasitic plant, and provided too with the black hairs.

Some naturalists consider this by far the most wonderful of all insects. It is, of course, a beetle. It is about an inch in length. When attached to

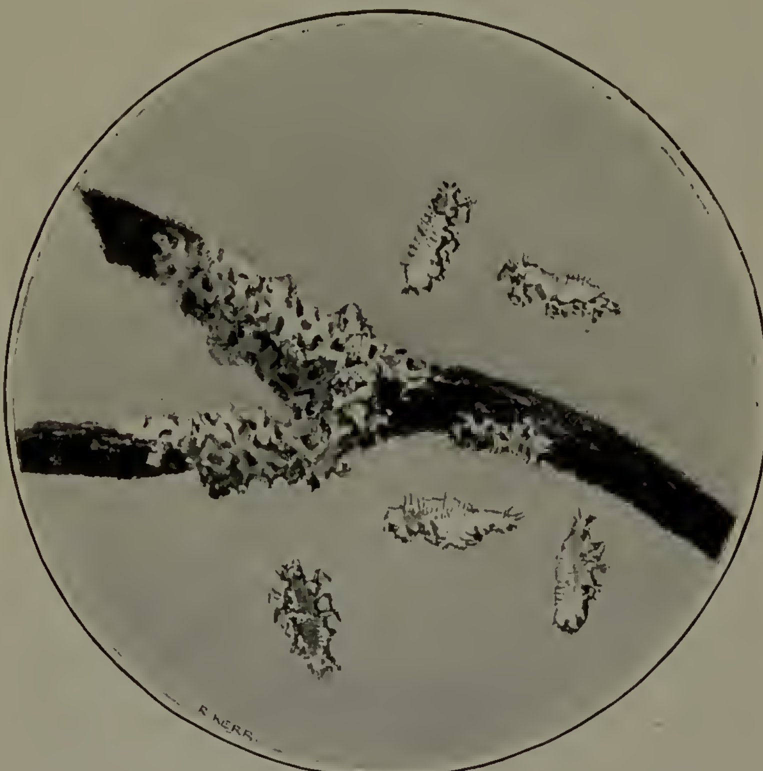

FIG. 18. LITHINUS NIGROCRISTATUS
The Rothschild Museum

the lichen it is next to impossible to detect it. In the tray of a cabinet, lying about, there is no great difficulty in seeing which are beetles and which the lichen.

But it should be borne in mind with these, as well as with several other creatures, that they are not by any means so easily seen in a state of nature.

These are among the many wonderful creatures from Madagascar.

CHAPTER VI

A £55 Shell and the Common Limpet (*Patella vulgata*)

THE creature that possesses a shell of such great value deserves more than a commonplace name.

In this instance the name is quite out of the common, and long enough to please any writer of labels for museum specimens. It is known as *Pleurotomaria adansoniana*, twenty-four letters in all! Throughout both words we are told to sound the letter 'a' as in 'ah.'

There is this satisfaction in repeating a few times the dual name of this creature, it becomes very easy and somewhat musical. Some one has said, and I agree with him, that when a person feels cross and wants 'to let off steam,' the repetition six or a dozen times of the title of this specimen would produce harmless results on both listeners and on the individual himself.

Animals of the *Pleurotomaria* class are muscular and very strong, and as their abode is away down

among the rocks at considerable depths in the ocean waters, it is not an easy matter to loosen them, and to 'land' them without doing damage to their shells. Possibly for these reasons so few shells of this particular kind have been found.

Great interest is attached to the finding of the very few that are known.

About forty years ago it was the general opinion that all the *Pleurotomaria* shells had become extinct.

The fossil representatives even were never found in unlimited numbers, like those of many other shell-fish.

In 1885 Dr. Woodward, F.R.S., announced the number of fossil specimens as 1156. Of these, 226 belonged to British rocks. Some value must be attached to this class of creature when even the exact number of its fossil remains is known to science

It was in 1855 that the first known living specimen was taken up by M. Beau, off the island of Marie Galante. This shell is known as *Pleurotomaria quoyana*, and the 'find' made no small commotion among the conchologists and geologists of the time. It was purchased in 1873 by Miss de Burgh, of London, for £25, a price that has ever since been considered very cheap indeed, although the height of the shell is not

one-third that of the *P. adansoniana* now under notice.

In the French *Journal of Conchology* for 1861 a description is given of another shell, *Adansoris*, which is three inches in height. This example, however, is not perfect. The third that came to light, in 1882, was a perfect specimen. It is a little larger than the preceding, and was picked up off Guadaloupe.

One or two specimens have been obtained from Japanese waters, and one from the waters around the Moluccas.

From all known sources the total members of the *Pleurotomaria* family amounts to fourteen, which are divided under six species.

The fact that only fourteen of these shells are known will, in some measure, account for their value in the estimation of collectors and museum curators.

This, the fourteenth specimen, was purchased by Mr. Damon, of Weymouth.

Having seen it when it was in that gentleman's possession, I am able to give some particulars as to its dimensions, etc.

Mr. Damon had plaster-casts made from the original. These were coloured and decorated by a skilful artist, so that it was not an easy matter to distinguish between the casts and the natural production.

The original shell may now be seen in the national collection in the Natural History Museum.

It is a matter of surprise to me that there is no

FIG. 19. PLEUROTOMARIA ADANSONIANA
After R. Damon

description of it in its case, nor anything to direct the attention of the public to its extreme value.

It was purchased by the authorities for £55.

Perhaps the curators, not wishing to provoke ill-will among the specimens, do not single out one, lest

they should hurt the susceptibilities of the many other treasures they possess; or possibly they wish to teach these rare representatives of natural history that modesty is becoming, and that real value needs no trumpeting.

This particular shell is the largest but one among the known series. It height and width are about six inches and a half, while the characteristic fissure extends round the shell to a length of nearly ten inches (fig. 19).

The shell has a groundwork of colour approaching a flesh-tint, on which are irregular markings of red and orange.

The markings on the first found specimen—the *Quoyana*—are in square patches.

Among the shells classed as 'Cones,' of which quite four hundred distinct kinds are known, some specimens are so brilliantly and beautifully marked that they fetch £50 apiece.

Some shells realise even more than this amount, so that we need not consider the *Adansoniana* to be unique among shells in the matter of value.

Should the promised submarine boat do all its inventor intends it to do in the way of exploring the bottom of the sea, we may reasonably expect specimens of *Pleurotomaria*, of *Conus gloria maris*, of rare wentle-traps of *Spondylus*, and of still rarer forms of life, in such abundance that a still greater

taste for and knowledge of Nature may take hold of the minds of the people.

Referring to our illustration, we observe that the outer lip exhibits a wide slit. It is of interest to notice that from the early stages of the shell-growth a slit has been present, but it is gradually filled up as the creature and the shell grow larger, whorl after whorl is added, and as the slit is filled, so a ridge appears in spiral order from the top whorl to the extremity of this peculiar opening.

The shell is nacreous on the inside. It would be a culpable error to remove the outer surface of the shell, for the purpose of exposing any other inherent beauty it may possess.

The forms of the shells of this group of creatures vary considerably. They are generally coiled up into an elevated spiral, and are somewhat flattened underneath; sometimes the base is convex. The horny operculum is always present.

As a fossil the oldest known specimens are found in the upper Cambrian rocks.

When a collection of shells is brought home from tropical seas and oceans, it is well to learn the value of them.

Not many years ago a basket of shells was taken to a dealer and surrendered for a small sum.

The dealer saw one specimen at the bottom of the basket which was worth many pounds. His

delight nearly caused him to express his surprise at the sum asked, but he kept his countenance, and the shell. It was a fine specimen of *Pleurotomaria*. So far as this shell is concerned, no such mistake can occur again to any one who studies for one minute the dimensions, shape, etc., of this specimen as illustrated, or, better still, the actual shell in the Cromwell Road Museum.

The Limpet

There is one fact, at least, that is very curious and deserving of notice about the Common Limpet, and that is its great strength.

It is said that the female flea (*Pulex irritans*) is the strongest animal in the world for its size, inasmuch as it can jump 300 times its own height, and draw a load nearly 1500 times its own weight.

The Limpet is not a jumper, but its strength appears to be proportionally greater than that of the flea, for it can resist a pulling force of nearly 2000 times its own weight before it will let go its hold on the rock to which it is attached.

In making experiments for ascertaining these particulars, the weight of the animal only, deprived of its shell, was reckoned. The creature weighed a small fraction under an ounce, and when pulled in a line at right angles to its place of adhesion it resisted a force of over 62 pounds. This was

tried in air after the tide had receded. Doubtless if the same Limpet had been tested under water it would have resisted even greater force, for a smaller Limpet which had resisted up to 32 pounds in air when tried after the tide had covered it, held on, although tired from its previous effort, until a force of over 54 pounds had been expended.

The force required to open an oyster is said to be nearly 1320 times the weight of the creature without its shell.

Hartwig, in *The Sea and its Living Wonders*, says it has been calculated that the larger species of Limpet are able to produce a resistance equivalent to a weight of 150 pounds.

Some naturalists are of the opinion that the Limpet's extraordinary power of adherence is partly owing to suction and partly owing to its power to eject a cement, by means of which it glues itself to the rock.

Others think that atmospheric pressure has little or nothing to do with this power of adhesion.

Apart from these opinions, the muscular strength of the foot of the Limpet must be very great.

The famous Limpet of the west coast of Central America (*Patella mexicana*), whose shell attains to a length of twelve inches, must be able to assert a prodigious adhesive power. Its shell does for a basin.

Vegetarians will be interested to know that this great strength may be traceable to the fact that, according to the authorities of the Natural History Museum, 'The Limpets are vegetable feeders and fond of seaweeds of various kinds, which they rasp with their spiny tongues.'

To the devouring appetite of Limpets may be partly attributed the annual destruction of the oarweed (*Laminariæ*), for, eating into the lower part of the stems and roots, they weaken the plants so that they become detached and are driven on shore by the winds and currents.

The rasp-tongue of the English Limpet is a wonderful contrivance, and is longer than its shell. It is furnished with 160 rows of teeth, each row containing 12, so that the tongue has on it 1920 glassy teeth.

The Limpet is used for bait in the sea-fishing off the Scottish coast, and it was computed at one time that over twelve millions of them were collected annually for that purpose, so that a scarcity was produced (fig. 20). Vast quantities are consumed as food in some parts of Ireland.

The famous conchologist, the late Gwyn Jeffreys, gave it as his opinion from his own experience that 'roasted Limpets are capital eating.' He says: 'A few years ago I was a guest at a dinner-party in the little island of Herm. The hour was unfashionable

—one o'clock—and the meal was served on the turf in the open air. This consisted of fine Limpets,

Fig. 20. The Common Limpet (*Patell a vulgata*)
Natural History Museu

laid in their usual position, and cooked by being covered with a heap of straw, which had been set

on fire about twenty minutes before dinner. There was also bread-and-butter. The company were a farmer, two labourers, a sheep-dog, the late Dr. Lukis, and myself. We squatted round the smouldering heap, and left on the board a couple of hundred empty shells.'

At distance viewed it seems to lie
On its rough bed so carelessly,
That 'twould an infant's hand obey,
Stretched forth to seize it in its play;
But let that infant's hand draw near,
It shrinks with quick, instinctive fear,
And clings as close as though the stone
It rests upon and it were one.

And should the strongest arm endeavour
The limpet from the rock to sever,
'Tis seen its loved support to clasp
With such tenacity of grasp,
We wonder that such strength should dwell
In such a small and simple shell.

Seaside Walks of a Naturalist.

CHAPTER VII

A Regal Shell-Fish and The Common Whelk

THE Purpura is a shell-fish which at one time was prized because of the purple dye it yielded for dyeing the robes of emperors. But it has been dethroned from its royal position, and now ranks with the ordinary sea-shells, owing to two discoveries—the use of the cochineal insect and that of aniline dyes extracted from coal-tar.

For centuries the Purpura was prized, in all probability, more than any other shell-fish, and it gave employment to large numbers of people. Historians have mentioned it, for it possessed an inherent treasure more valuable than gold, and was a source of national and imperial pride.

But industries, however great, must give way to the march of science, and so the natural and, doubtless, beautiful dye of the shell-fish is eclipsed by the work of the modern chemist.

A parallel case occurs as regards the lovely blue

colour used by the old masters in the skies of their landscape pictures. They ground up lapis-lazuli and made their own tints of blue. It was costly in those days, for it is on record that as much as three hundred pounds' worth of this paint was sometimes used in one painting of a sky. But the chemist, at a small cost, produces cobalt that now completely removes the use of the 'sky-blue stone' of the ancients.

But, to return to the symbol of imperial power, the purple, which has recently been brought to our notice during the days of mourning for our late beloved Queen.

The only purple prized in ancient times was the Tyrian. It was very beautiful, and very costly to produce, and it was the most highly valued of all the colours known in the days of the Roman emperors.

P. L. Simmons mentions that in the days of Augustus one pound of wool dyed with Tyrian purple sold for £36. We need not wonder at this enormous price when the tedious nature of the process, and the small quantity of the dye obtained from each mollusc, are taken into consideration.

There were two kinds of shell-fish used—the Murex and the Purpura. For dyeing fifty pounds' weight of wool two hundred pounds of liquor of

Murex and one hundred pounds of that of Purpura were used—that is, six pounds of liquor for each pound of wool. It is not a matter of wonder, there-

FIG. 21. PURPURA SHELL AND TWO WHELK SHELLS
(Sinistral and Dextral)

fore, that the finished Tyrian purple fabrics vied in value even with gold.

The enormous heaps of these particular shells found at Otranto and at other places in the Levant,

etc., seem to indicate the exact localities where the establishments for catching the shell-fish, making the dye, and dyeing the wool, formerly existed.

All writers about this shell-fish are agreed that immense numbers of the molluscs were required owing to the very small quantity of the dyeing fluid that could be obtained from each creature.

The British representative, which also yields a dye, is *Purpura lapillus* (see the small shell, fig. 21). When the creature is removed from its shell there is seen on its back a small, whitish vessel, containing a yellow fluid. When this is applied to linen and exposed to the sun, it becomes green, blue, purple, and finally a permanent crimson.

In different localities the Purpura produce differently coloured dyes such as black, violet, and rich red, so that by mingling the dyes of several varieties of shell-fish they could produce three or four different shades of purple.

Some of the Tyrian garments had a beautiful play of colours, like the shot silks of our own time, and writers tell us that this play of colouring was first suggested to the ancient dyers by having observed a similar one on the neck of a pigeon.

The Purpura belongs to the family *Buccinidæ*. Another member of the same family of molluscs is a larger shell-fish, the Whelk.

The Common Whelk

Two illustrations of Whelk Shells are shown with that of Purpura in fig. 21.

The ordinary or 'dextral' form of the shell is that on the right, in which the helix is said to be right-handed. But occasionally, about one in some millions of shells, the spiral is reversed, and is said to be 'sinistral.'

Collectors are always eager to secure that with the helix left-handed. In the course of several years I have only been able to obtain two specimens of the 'sinistral' example.

This creature is usually known as the 'common whelk,' because it is so plentiful not only around the British coasts, but in the Atlantic and away as far as Greenland.

It is usually taken in deep water about six hundred feet from the surface, and is used as an article of food.

Sometimes the fishermen bring them in such quantities that they are spread over the land.

The creature's head is broad, and is furnished with two tentacles or feelers and two stalks on which the eyes are placed. There is also a proboscis and a toothed tongue—odontophore—which is a marvellous structure.

This tongue is greatly admired as an object for the microscope, or better still for the polariscope attached to that instrument.

The tongue carries a series of teeth all along its whole length, which the Gasteropod uses for boring holes in the shells of other molluscs, such as the mussel or cockle.

The boring faculty of the Whelks was mentioned by Aristotle more than two thousand years ago. He described the stout proboscis, the sharp teeth, the sense of smell evidenced by the creature being attracted from a considerable distance by the bait laid for its capture.

He also noticed the honeycomb mass of spawn deposited by this shell-fish.

The boring process which it adopts for obtaining food is an extremely slow one. It occupies nearly two days before completing a hole in the shell of a mussel and gaining access to the interior.

The strap-like tongue, according to Jeffreys, with its rows of teeth, works with a rotatory motion, and produces an aperture shaped like an inverted cone.

Pre-historic man has left evidence that he liked the Whelk and the Purpura, for vast numbers of these shells are found in the famous refuse heaps (kitchen-middens) on the shores of the Baltic, in the north of Scotland, etc.

The Whelk has been a borer from very early times, for several bivalve and univalve fossil shells from rocks of great age show similar perforations, undoubtedly done by contemporary Whelks.

J. Gwyn Jeffreys, Osler, Hancock, Bretherton, and other observers have shown that the boring is accomplished by this marvellous tongue, and that under the microscope the inverted cone exhibits extremely fine scratch-like striæ, as if caused by the rasping action of the tiny teeth of this lingual apparatus.

When it gets through the shell it does not appear that the prey is destroyed by any poisonous secretion of the Whelk. The victim is sure to open its shells apart if it be a bivalve, or, if a limpet, it will let go its hold on the rock, and then the voracious cannibal devours it by the natural opening. In the early stages of its attack, after the hole is completed, it obtains some of its food by inserting the proboscis through the hole it has bored in the shell.

CHAPTER VIII

The Watering-Pot Shell, The Wentle-Trap, and Ianthina

ONE end of Brechites looks very much like the rose of a watering-pot, while the other end resembles a series of frills or flounces. These peculiarities of shape give it a value in the eyes of collectors of shells. But there is one other remarkable circumstance connected with it which is even more peculiar, but which is not apparent at first sight. In classifying this specimen one would be disposed to place it among the univalves, as only one shell is visible, but this would be a mistake. It belongs to the bivalves, for the following reason. In the early stages of its existence the creature possessed two shells, like those of the cockle or any other bivalve; and one has to search carefully to find these two shells. They are situated just above the rose end, embedded in the shelly tube. Although very small compared with the long tube, they were the original valves, which for a

FIG. 22. THE WATERING-POT SHELL (*Brechites*)
Natural History Museum

time protected the young creature, the large tube being a subsequent secretion or construction, or possibly both combined. The perforated disc or rose closing the end of the burrow is secreted when the animal is full grown. Like most other molluscs, this creature has a mantle which develops into a cylindrical shape and which secretes a continuous shelly tube, so complete that it replaces the ligament and cements within its substance the two tiny shells of the creature in its young stage.

It will be seen that the watering-pot shell is an instance in which a very close and careful examination is absolutely necessary, in order to enable a student to classify with certainty (fig. 22).

Linnæus originally figured this shell and called it *Aspergillum javanum.* In 1841 Richard Owen gave the name *Aspergillum* to the 'Venus's Flower-Basket,' one of the glass sponges.

There are several fine examples of the watering-pot shells—*Brechites*—in the Natural History Museum. They are marine borers, but they do not appear to bore wood or stone like the Teredo and Pholas. They sink vertical shafts in the sand and mud along the low shores of the Indian and Pacific Oceans, and are generally found with the rose end downwards.

The tube is calcareous, showing that the creature has power to extract carbonate of lime from the

sea-water. It is thick and very strong, and sometimes attains to the length of nine or ten inches. The animal is attached by muscles to the interior of the tubular shell.

The uses of the holes in the disc are a matter of doubt. M. de Blainville thinks the small tubes at the rose end are intended for the passage of muscles which are necessary to fix the animal to the body on which it is to live, and in such a manner as to admit of its movements round a fixed point.

The creature lives in the upper part of the tube, and can elongate or contract itself at pleasure.

The shells are rare. Some have been found in the Red Sea and in the waters around the island of Java. The shells are white or yellowish. Some have the tube covered with sand mixed with fragments of shells of different colours.

Little or nothing is known of the creature's habits. Having with considerable difficulty located the tiny bivalve shells in the tube mass, naturalists appear to have gained no further information about the anatomical details or life history of this curious creature.

The Wentle-Trap

The shell of this creature is very beautiful, and at one time, when few specimens were found, as much as £100 was paid for a single shell.

It is recorded by T. Rymer Jones that this amount was realised in France, while specimens in England fetched £20 or £30. Even now the shells fetch a good price, but not such a large sum owing to the facilities in travelling.

The Wentle-trap is found along the south-eastern shores of Asia, and up to the Chinese waters. The purity of the shell, its spiral form, and the regularity of the outside staircase, all combine to make it a thing of beauty. It is closely allied to the purpura and the whelk shells, and has many points of resemblance to them.

With regard to the spiral form of this and other univalve shells, J. E. Taylor says : 'The law which regulates even such an apparently trivial matter as the mode in which shells of univalves twist or turn, is as mathematically true as the conic sections we find entering into the orbits of planets and comets. The late Canon Moseley showed that the size and distance between contiguous whorls, in such shells as the Common Wentle-trap (*Turritella communis*) of our shores, followed a geometrical progression. The spiral formed is logarithmic, of which it is a property that it is everywhere the same geometrical curvature, and is the only curve, except the circle, which possesses this property. Following this law, the animal winds its dwelling in a uniform direction through the space around its axis' (fig. 23).

We cannot forbear quoting Dr. Moseley's own remarks on this subject, which will be found in a paper contributed to the *Philosophical Transactions*

Fig. 23. The Wentle-Trap (*Scala scalaris*)

as far back as 1838. 'There is traced in this shell the application of properties of a geometrical curve to a mechanical purpose, by Him who metes the dimensions of space, and stretches out the

forms of matter according to the rules of a perfect geometry.'

Then Dr. Taylor goes on to say: 'There is another circumstance in connection with univalve shells we would mention. It is evident that, in aquatic mollusca, the shell must not only be a habitation for the animal, but a float. This it becomes through the portion of the narrower extremity of the shell being left unoccupied. But in order to preserve its buoyancy, and enable the animal to ascend and descend the water at will, it is necessary that the increase in the capacity of its float should bear a constant ratio to the corresponding increase of its body. This ratio always assigns a greater amount to the former than to the latter. It is in accordance with the geometrical character of the form assumed, that the capacity of the shell and the dimensions of the animal do increase in a constant ratio, causing the whole bulk of the animal to bear a relation of constantly increasing inequality to the whole capacity of the shell. The subject is one of profoundest interest, not only to naturalists, but also to mathematicians. . . . Enough has been said to show what important laws underlie such seemingly trivial things as the shape and size of a univalve shell to the mollusc that inhabits it.'

In some recent works the Wentle-trap is known as *Scala scalaris*.

The Ianthina

The letter 'J' often takes the place of the first letter of this creature's name.

The Ianthina is a marine shell-fish, and the spiral shell it inhabits is of a lovely blue. It floats by spreading out its 'foot' on the surface, but it is more usually found attached to the different kinds of 'Portuguese Man-of-War,' or in the mid-Atlantic in the wandering islands of Gulf weed.

At certain seasons a peculiar kind of membranous float or raft is secreted from the animal, like a piece of honeycomb with the cells filled with air. The egg-sacs, which are not unlike those of the common whelk, are attached beneath the float, and when all is complete and the egg-sacs full, the creature disengages it, and leaves the eggs to be hatched as the float drifts about on the surface in the warmth and sunlight.

The empty shells are common among the globigerina ooze on the Atlantic floor two and a half miles below. They are not unfrequently cast up on the shores on the west of Scotland and Ireland. Ianthina are not, however, inhabitants of our northern seas, but are drifted along and scattered about by our beneficent ameliator, the Gulf Stream.

Dr. S. P. Woodward, in his *Manual of Mollusca*, says: 'They are gregarious in the open sea, where

they are found in myriads. They frequently drift to the southern and western shores of Great Britain when the wind continues long from the south-west. In Swansea Bay they have been found quite fresh. When handled they exude a violet fluid from beneath the margin of the mantle.'

The capsules beneath the further end of the raft have been observed to be empty at a time when those in the middle contained young with fully formed shells, and those near the animal were filled with eggs.

They have no power of sinking or rising in the water. The raft, which is much too large to be withdrawn into the shell, is a curious apparatus attached to the rudimentary foot. This opinion is supported by Lucaze-Duthiers, who has seen it built up from glutinous matter secreted by the foot. The float is admirably adapted to the purpose for which it is used.

The word Ianthina implies that the shell is violet coloured.

The raft with its load of eggs underneath is shown in fig. 24.

The notched lines near the margin of the shell on the creature's body are the gills, while the tentacles and eye-stalks are near the upper portion of the cone-shaped body.

The illustration is adapted from that of Dr. S. P. Woodward's.

Writing of the Ianthina in *The Ocean*, P. H. Gosse says: 'Each specimen contains three or four drops of a blue liquid, which some writers suppose is sufficient to answer the purpose of concealment, as in the case of the cuttle-fish making its cloud in time of danger. But it is hardly sufficient for the purpose of imparting an obscurity to the water, as the whole quantity secreted by one animal will not discolour half a pint of water.'

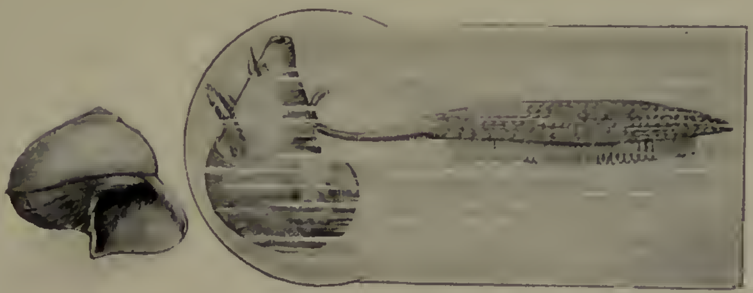

FIG. 24. THE VIOLET SHELL AND ITS RAFT (*Ianthina communis*)

After Woodward

CHAPTER IX

The Carrier Shell, The Teredo, and Cameo Shells

MEMBERS of the Crab tribe have their skeletons on the outside of their bodies, thus avoiding the necessity for 'X-Ray' operators.

But some of them are not content with a respectable hood, shell, or covering, for they like to add bunches of sea-weed, either for ornamentation, or for the purpose of concealing themselves. In this way they are so much covered up that it must be difficult to see them on the sea floor. Specimens of crabs that do this may be seen in the Cromwell Road Museum. One of them, the *Maia squinado*, is a very fine example.

There are shell-fish too, that seem not to be quite content with all that Nature has given them.

Creatures that we could name in a higher scale of the animal kingdom are similarly afflicted.

The creature we know as *Phorus onustus*—that is, the heavy-laden Phorus—is provided with a very

excellent shell; but, if the late Professor Drummond's theory about the hermit crab appertains to this shell-fish, there must come a time when the shell of Phorus will become as thin as tissue paper.

It has the remarkable habit of cementing to the exterior of its home fragments of other shells or pebbles. Some will use stones only, others will only use shells, so that for this reason, according to the kind of material they appropriate, they are called 'mineralogists' or 'conchologists.' Why does the Phorus do this?

We are told that the plan is adopted for the purpose of disguising its shell, and consequently for its protection. Its house is its castle, but apparently the creature does not think it sufficiently safe, so it sticks on pieces of other shell to make it safer (fig. 25).

But, mark you, the added pieces of shell are not put on in *any* fashion. Almost invariably the inside surface of each fragment is so placed as to face outwards. Why? It seems to some observers that Phorus is acquainted with the boring powers of another creature—the whelk or the purpura (see remarks on Whelks), which lives by boring holes in the shells of other shell-fish, and then eating them out of house and home; so friend Phorus appears to adopt a plan of throwing the borer off its guard. The whelk comes along, and, finding the inside of

each piece of shell outward, it concludes that the tenant is absent, and passes on to another shell. No one ought to dogmatise on this point, or upon

FIG. 25. THE HEAVY-LADEN SHELL (*Phorus onustus*)
After Reeve

any point in science, but it is certainly curious and well worthy of observation and of research.

A conchologist of many years' experience, and the curator of a large museum, says he has never

seen a bored shell of Phorus. This is remarkable, because nearly every kind of bivalve and many of the univalve shells show auger holes beautifully drilled out by the toothed-tongue or odontophore of some such creature as the whelk. Even fossil shells show similar borings.

Another variety of Phorus is actually buried in the mass of materials which it piles on its shell. The specimens brought home in the *Challenger* surpass anything previously seen, not so much in the mere mass as in the selection and arrangement of their foreign burdens of shells.

It may be that the addition is an attempt to copy the surroundings of the living animal ; in fact, it may be a case of protective mimicry.

Poulton, in his *Colours of Animals*, writes : 'Many of the Gasteropodas include pieces of shell, rock, coral, etc., in the edge of the growing shells. The effect is probably to obscure the junction between the shell and the surface on which it rests, and thus to assist in rendering the organism difficult of detection. Thus the growth of the shell may be traced by the spiral line of included fragments.'

The added shells and stones on Phorus are arranged in such a methodical order that it would require considerable skill on our part to place them better, while all our knowledge of chemistry would

not enable us to prepare a cement that would stand the sea so well as that prepared by Phorus.

Whatever may be the creature's motive in burdening itself with such a load, it is a fact in nature well worth our attention. Its method of selecting and fixing these foreign bodies seems to show instinct of a surprising order.

Another member of this family, *Phorus corrugatus*, so called because it is wrinkled, selects *flat* pieces of shells and stones and agglutinates them around the margin of the base of the whorls, so that they become inserted edgeways, ranging with great regularity side by side.

Many very wonderful representatives of the Phori inhabit the eastern seas at depths from thirty to sixty feet. In some works the genus is known as *Xenophora*, a word implying 'I carry strangers.'

An American work, Tryon's *Structural and Systematic Conchology*, contains the following statement :—

'The "carriers" inhabit deep water and are most numerous in the Java and Chinese seas. Each species appears to have its own particular method of collecting the fragments of shells and stones which cover the ground where it lives, and each cements to the outside of the shell its particular kind of materials.

'The adventitious pieces of shell are so disposed

as not to curve downwards beyond the edge of the shell so as to impede the progress of the animal, but are usually placed with their concave sides uppermost, and the purpose of this structure is evidently concealment of the true nature of the animal, either for attack or defence, or perhaps for both occasions, as when *tricked out* with shells and stones it may well be mistaken for a refuse heap.'

It must be borne in mind that whatever Phorus adds to its shell, whether shells or stones, they are so firmly fixed that it takes some violence to remove them. The work is well done, not scamped.

In the Natural History Museum there are several fine specimens well worth examination.

The Phorus adds enormously to the weight of its shell. Its efforts to move along on the bed of the sea among stones, shells, and pieces of coral, etc., must be very much greater than they need be.

Its muscular power is, no doubt, developed very considerably, but we should expect its shell to suffer severe degeneration.

The Teredo

A worm-like mollusc that nearly caused the ruin of an industrious nation, and whose methods of procedure have baffled marine biologists for many years, is our present subject for consideration.

In 1732 the people of Holland became aware

that their coast was threatened with destruction. The piles supporting the sea-walls were attacked by a more dangerous foe than ever came with ships laden with men and cannon.

The Teredo, a mollusc eight or ten inches long, had attacked the wooden foundations of their dykes. 'The people prayed and fasted in terror of such a calamity as seemed inevitable and which they did not know how to avert in any other manner. At length they were delivered from their fears by a hard frost, which effectually destroyed their dangerous enemies.'

Thus a tiny, apparently unimportant creature had struck terror in the hearts of a nation which had laughed to scorn the tyranny of Philip II., and bid defiance to the legions of Louis XIV.

An enormous sum of money was expended in order to make good the damage done and to render the sea-walls secure against any similar attack in the future.

On paying closer attention to the habits of the animal, it was found that the mollusc has a great aversion to iron-rust. It was necessary therefore to impregnate with oxide of iron all the wood used for dyke-building purposes. The creature is also powerless against copper, hence the custom of covering the bottoms of wooden ships with sheets of copper secured by copper nails.

Quatrefages relates the following circumstance: 'A boat, which had served as a passage-boat between two villages on the French coast, went down in consequence of an accident, at the commencement of spring. Four months after some fishermen, hoping to turn her materials to advantage, raised the boat. But in that short space of time the Teredo had committed such ravages that the timbers were riddled so as to be totally useless.'

They are destructive to ships, piers, and all wooden structures that are not protected with metal, and when once attacked they are soon riddled through and through.

As a rule they work in companies, and they rarely ever interfere with each other, or cross each other's path. The passages may be almost touching, but they rarely intersect.

In this wonderful instance of instinct they closely resemble the bark-borers referred to in another chapter.

It is misleading to call them 'ship-worms,' as they are true bivalve molluscs.

Moquin-Tandon, Figuier, Houghton, and several other writers on marine life readily recount the damage done by the Teredo to shipping, piers, dykes, etc., and some of them go as far as to call the creatures 'vandals,' 'contemptible molluscs,' 'miserable worms,' and the like; but is there not

another side to the question? Does not the creature render invaluable service to man by destroying floating timber brought down to the sea by rivers, and by riddling wooden ships wrecked in every sea and on every coast in the world, causing them to fall to pieces, and thereby preventing the choking up of estuaries and clearing the oceans, so that rapid traffic is less dangerous? If there were not some such agency at work night and day, the mouths of the rivers and all harbours would long ago have been rendered useless and the whole system of shipping would have been retarded.

The small amount of damage done to dykes and piers, although gigantic in one sense and involving a great outlay of money, does not in any way appear to eclipse the good done by these creatures, if we look fairly and impartially at their work. They are benefactors rather than enemies to the human race.

It may seem heresy to say so, but evolution, as explained by Darwin's would-be interpreters, by no means accounts for such a wonderful supervision of and forethought for man's needs, as is shown in the ocean-clearing work perpetually done by the Teredo. Nothing short of a providential purpose in adapting the creature to this special work seems to me to explain this wonderful circumstance in nature.

The tiny shells which only cover the most vital

parts of the creature are almost useless as a protection; but when the animal excavates a passage in submerged timber, it lines it with a secretion of carbonate of lime. Along this tube the sea water passes to the creature's body and conveys food. This arrangement is necessary, because the Teredo is imprisoned at the bottom of its tube. The body is elongated and bifurcated towards the end into two small tubes, one of which conveys the water to the gills, while the other takes away the used water and woody pulp. The shelly tube lining the passage can be closed by the little pallets or paddles which are located at the end of the body.

Many theories have been advanced to explain the manner in which the Teredo drills its wonderful passages. The bivalve shells are now considered too frail for the purpose. It was thought that the creature secreted a liquid, which dissolved woody fibre. But against this theory it has been urged that whether the wood be attacked across or with the grain, or whether both hard and soft parts be encountered in the same boring, the groove is uniformly smooth, and as neatly excavated as if by the sharpest instrument (fig. 26). A corroding liquid could hardly act with such uniform regularity. Tender parts and hard parts could not be equally acted upon by any chemical solvent known to science.

Quatrefages asks us to bear in mind that the

FIG. 26. WOOD BORED BY THE TEREDO NAVALIS

wood is saturated with water, and therefore is more amenable to any friction brought to bear upon it

and he has come to the conclusion that the rough, fleshy parts of the animal, probably the foot or mantle, acting as a rasp, forms the true boring instrument.

Cameo Shells

There are several kinds of cameos, according to the nature of the material employed.

At the present time in Rome and in Paris an extensive trade is carried on in the cutting of *shell* cameos, which are imported in considerable numbers into England, and mounted as brooches by Birmingham jewelry manufacturers.

Shells consisting of layers of different colours are mostly used. The design or image is cut in relief in one or two layers, while the next acts as the background.

All the Cassis varieties, whether from the East or West Indies or from Madagascar, are best adapted for the purpose. The ' Bull's Mouth ' Shell, *Cassis rufa*, is liked best, because of its flesh-like underlayer (fig. 27).

Many of the designs show very great skill, and are beautiful pieces of workmanship.

However skilfully done, the shell cameos can never be looked upon as anything more than imitations.

The real cameos of value are those cut in gems.

The stones that were selected were chiefly those that consisted of layers, such as agates.

Portraits of celebrities and other designs were

FIG. 27. CAMEO SHELL (*Cassis*)

exquisitely carved in one or more layers, and frequently advantage was taken of the various colours of the stone to make the picture more real. The under layer or layers formed the background.

It is probable this art had its origin in Asia. It was certainly practised in Babylon, and introduced into Egypt by the Phœnicians. The Greeks and Romans carried it to very great perfection.

Drinking cups were made out of a single agate or chalcedony, having cameos for their outer surfaces.

St. Petersburg is said to possess the finest antique cameo in the world, the Gonzaga. It represents two heads, supposed to be those of Ptolemy and Eurydice. The finest in England is in the Marlborough collection. It represents Cupid and Psyche.

The ancient cameos that have come down to us are mellowed, but not injured, by time, and are of priceless value, as illustrating the artistic culture and feeling of the age to which they belong. The historian must value them highly because they show the civilisation, morals, and manners of the various periods and countries.

The inferences to be drawn from classical sources as to beliefs, dress, usages, domestic and public habits, and the pursuits of the people are authentically confirmed by means of such gems.

Even the actual portraits of the most prominent personages in the world's history are faithfully preserved, and can be identified without the shadow of a doubt.

The Barberine or Portland Vase is one of the most beautiful examples of the ancient glass cameo.

The famous potter Josiah Wedgwood introduced a method of making imitations of cameos in pottery by producing white figures on a coloured ground, thus constituting the peculiarity of what is known as Wedgwood ware.

The manufacture of shell cameos is very recent. It originated in Rome in 1805.

CHAPTER X

The Acorn Barnacle and Toxotes

A CREATURE that 'kicks its food into its mouth,' to use Huxley's words, and that lives with its head glued to some foreign body, such as a piece of wood, a stone, or a shell-fish, must be reckoned among the curiosities of nature.

The great changes through which many animals pass before they reach the perfect stage are very wonderful, and those of the Acorn Barnacle are possibly among the most remarkable. So, for several reasons, they are worthy of notice. In fig. 28 we see a group of these creatures' shells attached firmly to a bottle. We know of no cement that will last so long or so securely fasten any given object under the continued action of sea water as that secreted by the Acorn Barnacle.

The creature is an adept at fishing. It opens the valves on the top of its home, and thrusts out its delicate feelers, that spread out like a net of curled threads; rapidly the net appears to be rolled

up and instantly pulled in with its supply of food. This process is repeated over and over again. The shell appears to be of one piece, but in reality it consists of six valves. This is the creature's only means of obtaining supplies, because in the adult stage it cannot move away from the spot to which it has attached itself. Its excursion days are over, unless it be attached to floating wood or the shell of some shell-fish that can move about.

Beginners will be surprised to learn that the Acorn Barnacle is a Crustacean, a near relative of the crabs and lobsters.

In fixing the position of any creature in the recognised scale of animal life, its whole life-history must be examined carefully.

When the young Barnacles are hatched and emerge from the shells, they possess organs of locomotion, and are like young shrimps or the tiny cyclops and water-fleas of fresh-water ponds. They wander about as they please, they have eyes, and in time they undergo a great change, in fact, two or three changes, until they seem tired of a roaming life and settle down, the head portion being made fast as already stated. The eyes disappear, the feet are replaced by six pairs of many-jointed appendages, called cirrhi, furnished with lashes (cilia). These cirrhi resemble a plume of feathers, and are always in motion when covered with the

Fig. 28. Acorn Barnacles

sea water. They expand like a concave net, and closing upon whatever may have come within their reach, they retract inwards.

The action of the cirrhi, besides procuring food and the material required for the enlargement of its shell, serves to aerate the blood, so that these delicate organs act both as gills and prehensile arms.

Although the Acorn Barnacles are in a sessile condition in the mature stage, they are not left without protection against the attacks of their enemies, for as danger approaches they shrink within their shells and close the openings against all comers. The shells, too, are substantially constructed.

The Acorn Barnacles of the coast of Chili are five or six inches across, and are esteemed as a delicacy.

The Chinese, after eating the animal of *Balanus tintinnabulum* with salt and vinegar, use the shell, which is about two or three inches high, as a lamp.

Mr. Darwin gives us a wonderful account of this creature. In its last stage as a free swimmer the creature's mouth is covered over with skin, so that it cannot eat anything. After swimming about for a time it selects its permanent resting-place. It puts its head against the piece of wood, shell, or stone, and holds on by its feelers until the glands secrete a cement, which hardens, and the creature is fixed. Standing on its head, it turns up its legs,

the surrounding shell is formed, and wonderful internal alterations take place. Its eyes, that were so useful when it enjoyed a free-swimming life, are now dispensed with, its mouth is opened, the creature is hermetically secured for the rest of its life; it grows, casts its skin, which forms the lining of its shell, produces eggs, and lives out its cycle of life.

The Toxotes

This remarkable representative of the finny tribe is common in the waters about the northern parts of Australia, and may be seen in tolerably large numbers at the mouths of the Endeavour and Norman Rivers and in the East Indies. It has the power of ejecting drops of water from its mouth at an insect on any adjacent plant.

It is known as 'The Rifle-' or 'Archer-fish.'

Dr. Gunther, one of the greatest living authorities on fishes, says: 'The Malays, who call it "Ikan Sumpit," keep it in a bowl, in order to witness this singular habit, which it continues even in captivity. There are two species known from the East Indies, one (*T. jaculator*) which is more common ranging to the north coast of Australia. It has received its name from its habit of throwing a drop of water at an insect which it perceives close to the surface, in order to make it fall.'

I have given this great authority's own words,

because another writer, judging from the shape of the creature's mouth, says it is a physical impossibility for Toxotes to send out jets of water with such accuracy.

As Mr. Saville Kent has lived in Australia for several years, and has devoted all his time to a careful study of land, estuarine, and marine life under all conditions (as shown in his gigantic contributions to natural scientific literature), I have referred to his unique work, *The Great Barrier Reef of Australia*, and I find not only a photograph of *Toxotes jaculator*, but the following interesting particulars. Speaking of the remarkable method of securing its food, he says: 'This consists chiefly of the flies that settle on the surface of the water-plants in its haunts, which it adroitly captures by discharging a small jet of water at them from its mouth. So accurate is its aim that the fly is often hit and precipitated into the water, where it is immediately seized from a distance of two or three feet.

'It is fair eating, but rarely exceeds a length of ten or twelve inches, or a weight of one or two pounds.'

The illustration is adapted from one of Mr. Saville Kent's (fig. 29).

Swainson and other writers bear out these statements.

Toxotes is not alone in his powers of shooting.

FIG. 29. THE RIFLE-FISH (*Toxotes jaculator*)
After Saville Kent

Dr. G. Hartwig, in *The Sea and its Living Wonders*, gives a wonderful account of the ingenuity of the

Chætodon in this respect. He says: 'But no fish catches its prey in a more remarkable manner than the *Beaked*, or *Rostrated Chætodon*, a native of the fresh-waters of India. When he sees a fly alighting on any of the plants which overhang the shallow water, he approaches with the utmost caution, coming as perpendicularly as possible under the object of his meditated attack. Then placing himself in an oblique direction, with the mouth and eyes near the surface, he remains a moment immovable, taking his aim like a first-rate rifleman. Having fixed his eyes directly on the insect, he darts at it a drop of water from his tubular snout, but without showing his mouth above the surface, from which only the drop seems to rise, and that with such effect, that though at the distance of four, five, or six feet, it very seldom fails to bring its prey into the water.'

CHAPTER XI

Iridogorgia, Isis hippuris, and Polyzoa

ALTHOUGH resembling a plant, the Iridogorgia is an animal, or, as some prefer to have it, a colony of animals. It is a beautiful object, as its name implies, and it is only found in the deep waters near the West India islands. It belongs to the lovely Gorgoniidæ, or Sea-fans. Its regular, upright stem arranged in spiral form makes it a very attractive object in a collection of marine curiosities. But, when living, its brilliant iridescent colours, embracing burnished gold, emerald-green and mother-of-pearl, give it a gorgeous appearance that is almost matchless among deep-sea fauna. The branches are undivided and are arranged in a single row throughout its whole length of twelve inches, and they stand out almost at right angles to the main spiral stem. Both stem and branches are flexible and are covered throughout with a gelatinous film studded at regular intervals with

minute polyps resembling tiny eight-rayed anemones. The axes of stem and branches contain calcareous particles, and the soft covering (*sarcode*) is filled

FIG. 30. SEA-FAN (*Iridogorgia pourtalesii*)
After A. Agassiz

with spicules. In this respect they are like the calcareous sponges. In classifying the various Gorgonians, marine zoologists pay great attention to the shapes of these microscopic spicules.

All the Sea-fans are attached at the base to the ocean floor or to coral or rocks.

To make a model that would convey an idea of the real beauty of the Iridogorgia in its native element, it would be necessary to make the spiral stem of golden cord tapering to the top, the branches should be fine golden threads studded with brilliants to represent the polyps. Glistening substances would have to be placed at intervals along the stem, and the whole played upon with coloured lights to show its changes of colour (fig. 30).

Black-and-white illustrations only help us to see the shape of the object on an enlarged or reduced scale. Even the beauty of the specimens themselves is considerably diminished, in fact almost obliterated, when they are removed from the bosom of the ocean, dried, and placed in museum collections. The student of the microscope, however, can remove from a very small portion of the dried specimen hundreds of beautiful spicules that have not suffered by the change. Many of the spicules are comparable to any taken from the most beautiful sponges.

Isis hippuris

Before leaving the beautiful Gorgonians we must notice a very curious member of the family. Its name –*Isis*[1] *hippuris*—implies that it bears a re-

[1] *Isis*, a goddess ; *hippos*, a horse.

semblance to the plant Mare's-tail (*Hippuris vulgaris*).

Its main structure, known as the corallum, is remarkably built up of two distinct substances.

It is curious, if not unique, that the two different substances should be arranged in alternate divisions and of different lengths. The larger divisions, or internodes, are chiefly composed of carbonate of lime. The smaller segments are composed of a dense, horny material, dark-brown in colour, corresponding to that of which the central column of all the Gorgonians is constituted.

Sarcode, as in the case of all the Sea-fans, envelops the stem and branches, and at intervals the polyps similar to those of all the Gorgonians are situated.

The calcareous divisions, disposed alternately with the horny substance, unite flexibility with firmness. The Mare's-tail Coral therefore bends before the passing wave, and is at the same time sufficiently strong to hold its own position, except in very great storms (fig. 31).

Polyzoa

Several authorities on micro-marine life prefer the name 'Polyzoa' to 'Bryozoa.' The former is more comprehensive and accurate The term 'Bryozoa' simply means 'moss-like animals.'

FIG. 31. SEA-FIR (*Isis hippuris*)

By 'Polyzoa' we understand that we are considering a colony of tiny living creatures. All the myriads of Polyzoa known to science live in great numbers with one exception. That exception is 'Loxosoma.'

The Polyzoa as we have said, are legion, for they include not only those that are living at the present time, but also all those minute fossil forms that are met with in many of the great fossiliferous rocks of the world.

In most instances a microscope is necessary to reveal their beauty, whether we set out to study the individuals alive in their natural element, or to see their marvellous homes or cells.

In the fossil forms there is enough for a lifetime's examination, even if one were to take a limited area like that of a chalk-pit, or a few cubic yards of the crag rocks on the east coast of England.

Living Bowerbankia or other colonies of life in sea-water for the microscope may be obtained in most of the shallow waters around our coast.

It would be difficult to pick up a piece of seaweed or an empty shell that has lain any length of time in the water and not find a Polyzoon of some kind or other attached to it. The scallop-shells, oysters, and whelk-shells that we see on the fisherman's cart or in the fishmonger's shop, often

contain untold numbers of these tiny denizens of the sea.

There are also many colonies of fresh-water forms of Polyzoa equally small, equally beautiful, and

Fig. 32. Polyzoa (*Bryozoa*)

equally wonderful. To see these creatures under the microscope, many of them below the range of vision, endowed with life, is a treat never to be forgotten.

The colony is said to be 'composite.' Each

creature or Zooid, however small, is said to consist of, or to possess, a double-walled cell or sac. It has a mouth and a digestive apparatus, a nervous

FIG. 33. POLYZOA (*Bryozoa*)

system! and a circle or crescent of feelers arranged around its mouth.

The law which regulates the colony, or the instinct, or whatever the guiding principle may be,

by which all these micro-creatures, some of them below the range of our vision, work for the common good, and produce a structure incomparably beautiful, is not easily explained.

The great Charles Darwin says: 'One Hand has surely worked through the universe.'

The two plates (figs. 32 and 33) contain eight illustrations of microscopic portions of Polyzoa. If we imagine each to represent a fragment no larger than a pin's head, we shall be able to form an idea of the complexity of structure in these attractive objects. The top drawing in fig. 32 gives us an idea of a Polyzoon named *Terebellaria antelopa* (D'Orb.). Of the lower ones, that on the extreme right is *Idmonea gibbosa* (Hagenow). The next is *Idmonea spiralis*. The remaining specimen on the left is *Clavicavea regularis* (D'Orb.).

Coming to fig. 33, *Seriotubigera francgana* (D'Orb.) is above. The lower specimens are all *Escharifora* (D'Orb.).

I am indebted to the works of Hagenow and D'Orbigny for these illustrations.

CHAPTER XII

The Land-Snail (*Helix pomatia*) and Bulimus

THE Land-snails—or, to express matters more scientifically, the terrestrial molluscs—are 'winter-sleepers.' In the winter months in cold countries they bury themselves among the roots of trees in the ground or wherever they can find shelter. Some members of the family are capable of prolonging their state of torpidity during astonishingly long periods. A writer in *Science Gossip* shows clearly that a specimen of *Helix nemoralis* maintained its torpid condition, while in his possession, for three years and a quarter! 'It walked about in as lively a manner as when first picked up.' All this may appear incredible, but the statement is amply substantiated in the following extract from the *Guide to the Shell and Starfish Galleries of the Natural History Museum*, issued under the auspices of Professor Albert Günther: 'In tropical countries some assume a state of torpidity during the hottest and driest season of the year, closing up the aper-

ture of their shells with a temporary lid or door, in order to resist the dryness of the atmosphere. Some of these "summer-sleepers" are endowed with a remarkable tenacity of life. An Australian pond-mussel has been known to live a year after being removed from the water; several Land-snails have revived after a captivity of from two to five years, without any food whatever. One of the most remarkable instances of this kind occurred in the British Museum. A specimen of *Helix desertorum*, a common Desert-snail from Egypt, was fixed to a tablet under a glass shade in March, 1846, and in the same month of the year 1850 it was discovered to be alive. It must have come out of its shell in the interval, and, finding it was unable to crawl away, had again retired within it, closing the aperture with a new epiphragm, but leaving traces of slime upon the tablet, which led to its immersion in water and subsequent revival, having passed a period of four years in a dry museum without the smallest particle of food.'

The Land-snail has a distinct head from which four tentacles are protruded. These are very sensitive organs of touch. At the tip of each of the larger tentacles is a minute but perfect eye.

At the creature's will the tentacles as well as the eyes can be retracted into the body cavity. The creature has no skeleton. Its body is enclosed in a

thick, muscular envelope, which can be shortened or elongated by the muscles composing it, allowing the shape of the animal to vary at pleasure. The foot is composed of an interlacement of muscular fibres. It forms not only an extensive sucker, but by the successive action of various portions of its substance a slow and gliding progressive motion is produced.

The creature has a wide mouth, containing a cutting instrument of singular contrivance. The tongue, known as the 'odontophore,' is covered, in symmetrical order, with rows of miscroscopic teeth, and is used for rasping purposes. This affords a beautiful object for examination under the magnifier. It is said to contain 20,000 teeth. The whole of the body can be drawn into and be protected by a spiral shell.

As a general rule the creatures are vegetarians. 'They are to be found in nearly every part of the world, and in all situations, from sea-level to an altitude of 12,000 feet. The *Helix pomatia*, which is found on the chalk in the south of England and on the Continent, is commonly eaten in Austria, France, and Belguim.'

A section of the shell shows a spiral arrangement of more or less complex structure (fig. 34).

But to return to the pair of tentacles containing the eyes. These are hollow tubes, and in being withdrawn they are retracted inversely, like the

fingers of a tight glove—the extremities, holding the eyes, are always the first to disappear.

When protruded, they are not lengthened by being pushed out from the base, but by a gradual unfolding process—the clubbed points, containing the eyes, appearing last. Everything relating to the human eye is considered wonderful, but the

FIG. 34. GARDEN-SNAIL (*Helix pomatia*)

After H. Wettstein

contrivances for the protection of this lowly creature's eyes are not less deserving of our admiration.

The animal carries its house along with it, into which it can retire when necessary—an exceedingly convenient arrangement, reminding us of Diogenes and his tub.

As lowly as this creature is, it has a heart

divided up by partitions; and it has a colourless blood circulation, the lungs doing similar duty to those of higher animals.

Brains are said to be wanting, but a large bunch of nerves is situated near the alimentary canal.

The creature lays about thirty eggs which are deposited in a hole in the earth. When the young are hatched, they are as perfect in shape as the parent, the shells being extremely delicate.

Certain varieties of Land-snails will only thrive in localities where there is abundance of chalk. They devour most kinds of vegetable food and prefer wet weather. Towards winter they bury themselves and form a chalky covering over the shell-opening.

These covered-shell snails are reared by snail-gardeners for the markets on the Continent.

Bulimus oblongus

The Bulimus also is a Land-snail, but a giant in comparison with its European representatives.

Bulimi are found in South America, the Solomon Islands, the Philippines, etc.

The specimen shown in the illustration is nearly five inches long, and the egg is more than an inch in its longest diameter. On showing these specimens to a fashionable audience recently, the egg portion of the story was received with considerable shakings of heads. Let those who doubt

the fact see the collection of Bulimi in the Natural History Museum, where several eggs are shown, one of which is partially broken to show the young Bulimus shell inside what appears to be a pigeon's egg-shell.

The eggs of Bulimi vary in texture and size. They are generally white, but in some instances yellow and pale green. Some of the egg-shells are as hard as those of a hen's egg.

In the rainless regions on the western slopes of the Andes the sterility has much the same effect on the Bulimi as the wintry colds of our own country. Reeve, in his famous work[1] on shells, relates the curious experience of Cuming, the great traveller-naturalist. When he arrived at Copiapo, where some of the finest specimens of Bulimi are to be found, he requested a native to obtain for him as many of the living specimens as possible. On the man's return, Cuming expressed his disappointment at finding so many of them dead. 'But,' replied the native, 'only wait till the dews come, and they will be all alive again.' 'I suppose you mean the rains?' said Cuming. But the poor fellow failed to realise his meaning. He was over sixty years old, and this was the first time he had ever heard of rain.

[1] *Conchologia Iconica.*

The natives roast and eat the Bulimi as a frequent article of food.

In several parts of these arid, sandy tracts some of the Bulimi remain all the year round on the numerous cacti ; but the greater number, during the hot season, which lasts several months, live in a

FIG. 35. SHELL AND EGGS OF BULIMUS OBLONGUS

state of torpor, enclosed within their shells by an epiphragm, and buried in the sand or under stones. On the approach of the dews they revive and crawl about at night in quest of food (fig. 35).

Cuming having explored the regions west of the Andes, visited the dense woods of Colombia and Central America, where the warmth and

moisture promote great development of vegetation, which exactly suits the Bulimus, for it is a great eater. He then proceeded to the Philippine Islands, chiefly with the object of collecting the shells of these giant land-snails. Here he found the climate and the vegetation such as to favour the growth of arboreal specimens. The genus is represented in these islands with great splendour. Cuming must have been overjoyed when he beheld the lofty trees of these sunny islands laden with snails of such magnificent proportions.

Specimens in English cabinets which were prized as very rare were found in abundance, and many new kinds were discovered. They could be dislodged by shaking the branches, but they are chiefly disturbed by the heavy rains with which these islands are visited.

These tree-climbers of the Philippine Islands give evidence of an ingenuity equal to that shown by several of the insect tribes. They deposit their eggs in little clusters on the trees between two leaves, which they manage to curl up one upon the other, so as to form a receptacle for their protection. The eggs are placed in parallel rows on end. A glutinous substance holds the lower ends to the leaf.

Lovely Bulimi are also found in the Solomon Islands. They are of large size, with shells of

the purest yellow, while the rims round the mouths are of a brilliant orange red.

It scarcely needs mentioning that the Bulimi are air-breathing molluscs.

The beautiful forms and varieties of shells produced by the Bulimi constitute an important division of the great tribe of snails. They are objects of especial interest to the conchologist, and it is surprising the zeal with which enterprising scientific travellers penetrate into the tropical countries in pursuit of them.

In Africa the largest of all known land-molluscs—the Achatina—are found. Their eggs are protected by strong calcareous shells fully an inch in diameter.

Bulimi are found in the fossil condition in the Upper Cretaceous rocks. So they are an ancient family.

In the *Daily Express*, August 12, 1901, appears a short article, entitled 'Industrious Snails,' which may interest my readers, but I do not ask them to accept all its details, inasmuch as it hails from the land of wonders and of large adjectives:—

'An old Philadelphia negress sells snails, not as food, but to clean window-panes. The snail is dampened and placed upon the glass, where it at once moves around and devours all insects and foreign matter, leaving the pane as bright and

clear as crystal. There are old-established business places in Philadelphia where the upper windows, when cleaned at all, are always cleaned by snails. There is also a fine market for snails among the owners of aquariums, as they keep the glass clean and bright.'

It is a pity to spoil a pretty American story, but it is only natural to ask, What about the slimy, glistening track left by each of these Gasteropods on the panes of glass in windows of the business houses of Philadelphia?

CHAPTER XIII

The Tailor-Bird, The Guillemot's Egg, Edible Birds'-Nests, and How Birds are Disguised

IT is an excusable error that students of Nature fall into when they exclaim, 'This is the most remarkable creature I ever heard of!' and a few minutes afterwards some fact about another creature will give rise to the same remark. It is so with microscopic research; it is so with the study of minerals and with every department of natural history. For the present the Tailor-bird stands highest 'in the realm of wonder.'

Here is a creature which could earn its living by making birds' nests for naturalists, if it cared to do so, and understood our high appreciation of its work. Yes, and it could lay by an ample fortune for its offspring; but this would tend to the degeneracy of its race, so that the beautiful art of stitching leaves together would fall into disuse, and great indeed would be the pity.

If only two or three specimens of the Tailor-birds' nests had ever been found, we might have been doubtful about the stitching performance ; but many writers have seen the birds and the nests, and have made careful notes of all details for our information. There are three or four nests so made in the Natural History Museum.

Among the travellers who have seen and examined the Tailor-birds' nests are Jerdon, Hume, Swinhoe, Gould, etc.

There are twelve species of Tailor-birds. Jerdon says of the Common Tailor-bird of India, *Orthotomus longicauda*, that 'it makes its nest of cotton, wool, and various other soft materials, and draws together one leaf or more, generally two leaves, on each side of the nest, and stitches them together with cotton, either woven by itself or cotton thread picked up, and, after passing the thread through the leaf, it makes a knot at the end to fix it'!

The late Alfred Smee had two nests, of which 'the birds had pierced the leaves with regular holes, and then with a little wool had made an in-and-out stitch precisely similar to that used by man.'

Hume gives a very full account of his observations of the Tailor-birds' nests. He says : 'The nest is a deep, soft cup, enclosed in leaves, which the

bird sews together to form a receptacle for it. It is placed at all elevations. The nests vary much in appearance, according to the number and description of the leaves which the bird employs, and the manner in which it employs them; but the nest itself is usually chiefly composed of fine cotton-wool with a few horse-hairs, and at times a few very fine grass-stems as a lining, apparently to keep the wool in its place, and enable the cavity to retain permanently its shape. . . . Many nests are made between two long leaves, whose sides, from the very tips to near the peduncles, were closely and neatly sewn together. . . . For sewing they generally use cobwebs, but silk from cocoons, thread, wool, and vegetable fibres are also used. The eggs vary from three to four. . . . They are *white*, spotted with rufous or reddish brown, sometimes bluish green similarly marked.'

He then says: 'I quote an exact description of a nest which I took at Bareilly, and which was recorded on the spot. . . . Three of the long ovato-lanceolate leaves of the mango, whose peduncles sprang from the same point, had been neatly drawn together with gossamer threads, run through the sides of the leaves and knotted outside, so as to form a cavity like the end of a netted purse, with a wide slit on the side nearest the trunk, beginning near the bottom

and widening upwards. Inside this the real nest, nearly three inches deep and about two inches in diameter, was neatly constructed of wool and fine vegetable fibres, the bottom being thinly lined with horse-hair. In this lay three tiny, delicate, bluish-white eggs, with a few reddish-brown blotches at the large ends, and just a few spots and specks of the same colour elsewhere. . . . The general colour of the male bird is olive-green, the head inclined to rufous inclining to grey, the legs flesh-colour, the eyes reddish-yellow.'

There can be no doubt whatever that such nests exist, and that they are the work of the Tailor-birds.

The birds generally go in pairs, sometimes in flocks, and are to be seen in hedgerows and gardens and amongst the jungles, incessantly hopping about, and often venturing close to houses. They are well known throughout China, India, and Burmah.

Alfred Smee, after describing a number of remarkably built birds' nests, including those of the Tailor-birds, says:

'In all cases which I have detailed, a fixed design, which is invariably maintained, is shown in the construction of the nest of each species. This permanence of plan is very remarkable when compared with the versatile operations of human beings; for it is manifest, if we compare the gypsy's

tent with the palaces of the Queen, or the mud-houses of the Irish and Welsh with mansions of the nobility, that even in this country the designs of our habitations vary extremely. With us there is no fixity of design. It is perpetually changed, to suit either our wants or our caprice. It is certainly true that the bird, in the formation of its nest, shows a power of construction which man, with his superior knowledge, may marvel at; nevertheless, the bird shows no other capacity to design—it can carry out this one idea, and no other analogous one requiring a similar amount of mental capacity [fig. 36]. From these facts we find that birds clearly build their nests upon a principle different from that with which man conducts his operations; and we find that birds build their nests without any manner or kind of experience.

'We are therefore compelled to infer that the design of the nest is inherent in the organisation, and that, under a certain stimulus, birds build nests upon a definite plan, which they did not originate, which they were not taught, but which they brought into the world with them.'

For all this it is a most wonderful performance, and we must place the nest of the Tailor-bird among some of the most remarkable things in creation.

An English lady who had a pair of these delightful birds in her Eastern home repeatedly had the gratification of seeing them actually stitching

FIG. 36. NEST OF TAILOR-BIRD (*Orthotomus*)

After Gould

the leaves together. It was a case of division of labour on the part of the feathered husband and his little partner. It was his duty to remain

perched outside the nest, to perforate the leaf with his beak; then he pushed the thread through to his little housewife. She, drawing it inwards with her beak, thrust it back again through a similar opening, which she had made near the edge of the next leaf; and so the work of stitching continued till the whole was considered secure.

Whether the power to construct so remarkable a nest be inherent in the organisation or not, it is none the less curious or beautiful.

The Guillemot's Egg

Every person who has seen a collection of guillemots' eggs must have noticed certain remarkable features about them. There are no two of them alike; the colour is not uniform for any number of them, no two are spotted or 'splashed' similarly. The shape of a Guillemot's egg differs from that of most eggs. That portion of the shell from a point near its greatest girth to a point in the same plane near the curve at the small end is almost a straight line. This lack of curvature reduces wobbling to a minimum, and causes the egg to roll around the narrow end.

There is definite purpose in this as in many other objects we are considering in this work. The bird lays one egg in the season, and this is placed on a bare ledge of rock high above the sea.

If the bird should stir it accidentally, or if the gust of wind were strong enough to cause it to roll, it would not wobble off the ledge, as an egg shaped like that of the hen would do. It would roll backwards and forwards around the narrow end, and remain within very limited bounds, so that it would thereby be preserved.

I have repeatedly tried an empty egg-shell on a table, which is an unfair test, and have always found it to rotate as I have described. Doubtless it is much safer when the egg is filled, as in its natural state.

It is quite evident that, if the eggs of the first Guillemots of long ages ago had been shaped on general oval lines, they would very soon have become extinct (fig. 37).

A word about the bird which lays this remarkable egg will not be out of place.

It is known by at least a dozen names, doubtless arising in the various localities it used to frequent ; for, at one time, the Guillemots visited almost every point around our coasts.

Before the passing of the Sea Birds Preservation Act the birds were ruthlessly slaughtered simply for sport (so called).

It is a picturesque bird, and a great deal of mystery is attached to its history. It arrives on our coasts in spring, lays its egg ; the young is

hatched, and towards the end of summer both parents and their offspring depart, but to what part of the world is unknown. A few may remain in out-of-the-way bays in shallow waters, but the vast hosts of Guillemots that may be seen in summer-

FIG. 37. EGG OF GUILLEMOT

time on the northern shores of our islands depart to other countries.

Generally speaking, the size of birds' eggs is constantly in proportion to that of the parent birds, but an exception occurs with the eggs of the Guillemot. This bird and the raven (*Corvus corax*) are about the same size, but the egg of the Guillemot is nearly ten times the volume of that of the raven. The eggs of the Guillemot are as large as those

of an eagle—a bird of much greater proportions than the Guillemot.

In speaking of the manner in which the eggs of the Guillemot are so peculiarly tapered, we must remember that certain other birds' eggs are also specially tapered, and some are quite pyriform in shape. In the case of those birds that lay four eggs in a nest, the eggs lie with their points almost meeting in the centre, and thus, occupying as little space as possible, they are the more easily covered by the parent.

Edible Birds'-Nests

The transparent nests of the Swift (*Collocalla*) are greatly valued by the Chinese for making soup. They are found in the caves of Sarawak, and on the face of the cliffs of Java, Papua, and in the Torres Straits.

They are more or less cup-shaped, and, to quote the authorities of our National Museum, they are 'formed almost entirely of a gelatinous material, secreted by the salivary glands of the birds.'

This does not appear to me to fully account for so much material as a nest contains. The bird is a small one, and to produce sufficient saliva, which, when hardened, must make a nest large enough for its home for hatching purposes, would involve an extraordinary output from its glands, to say nothing

of the time required for the purpose. This would be making bricks without straw in no small degree.

Several years ago Dr. Kelsall, an experienced and observant traveller in the East Indies, noticed that the surface of the sea in the neighbourhood of coral reefs was covered with long streaks of tenacious slime, which he found was an exudation from the skin of the trepangs which abound on the coral reefs. He repeatedly saw large numbers of these birds, gathering with their beaks this white slimy froth, and flying off with it. 'The bird,' he says, 'is a diminutive martin, and builds its nest against the face of the rock, just as the English martin constructs its mud nest under the eaves of our houses. As these little martins, with all the swallow tribe, are insectivorous, they were, no doubt, collecting the exuviæ of the trepang, not for food, but as the material where-with to construct their nests, the slime being moist and plastic, when first thrown off, and hardening into a kind of dry isinglass when put into shape by the bird.'

Whether this be sufficient evidence or not, it ought not to be a difficult matter to submit a nest and the exuviæ of the trepang to an examination both microscopical and chemical, to settle the question.

There is another point raised by Dr. Kelsall's

FIG. 38. EDIBLE BIRDS'-NESTS
Natural History Museum

account. The Chinese have a strong liking for trepangs, and pay a price ranging from five to

ten shillings a pound for them. Their annual import of trepangs amounts to 45,000 cwts. The supply is mostly from the Great Barrier Reef of Australia.

As for the edible birds'-nests, these are imported into Canton alone at the rate of nine millions in one year! Their value is ten shillings an ounce! It takes fifty nests to weigh one pound. Possibly, therefore, the flavour of the trepang and that of the bird's-nest are alike, for the Chinese like both. If so, this would lend colour and support to Dr. Kelsall's theory.

The illustration (fig. 38) is from the specimens in the Bird Gallery of the National Collection.

A Splendid Model

A most ingenious illustration of protective colouring, explanatory of Nature's wonderful method for the protection of many kinds of birds, etc., is to be seen in our famous Museum, to which I make so many references. It has been thought out and very cleverly executed by Mr. Abbott H. Thayer of America.

Every one must have noticed that the feathers on the ventral or underneath side of the bodies of most wild birds are white, and also the prevalence of browns and greys on the plumage covering the back and upper portions of their

bodies. Personally I never thought of inquiring into the reasons for this condition of things. It has remained for Mr. Abbott H. Thayer to educate me as regards this very important fact in Nature. A careful study of his models will repay every admirer of the wonders of creation.

Fig. 39. How Birds are Disguised

For the sake of those who may not have access to the Museum I venture to describe his models in words almost identical with his own, and I append an illustration which is but a poor substitute for his handiwork.

There are two models of birds to show the

effect of dark (dorsal) and light (ventral) coloration in counteracting the normal light and shade, and so rendering the bird invisible at a short distance (fig. 39).

'Both models are clothed with the same grey material with which the box is lined. The model on the right hand is otherwise uncoloured, and is rendered very obvious by the illumination of its back and the shading of its ventral surface—thus showing that mere identity in the colour of an animal and its surroundings does not protect it from view.' At this point I would remark that, when the case is placed out in the full light, it is almost impossible to believe that the bird on the right is covered with the same material as that which lines the box. Owing to the light falling from overhead, the back of the modelled bird on the right appears perfectly white instead of dark grey. 'The model on the left is skilfully painted with a dark tint on the back and with white underneath, a contrast not unusual in animals of all kinds. The result is that at a distance of four feet the left-hand model is invisible.' Nature does what the artist does with his paints. The birds and other creatures are darker above and lighter below, to counteract light in the one case and shadow in the other. Mr. Thayer, we must observe, does not limit this general law

to birds only. The cases in the Museum will supply many interesting examples of other creatures as well as birds which show this in a marked degree.

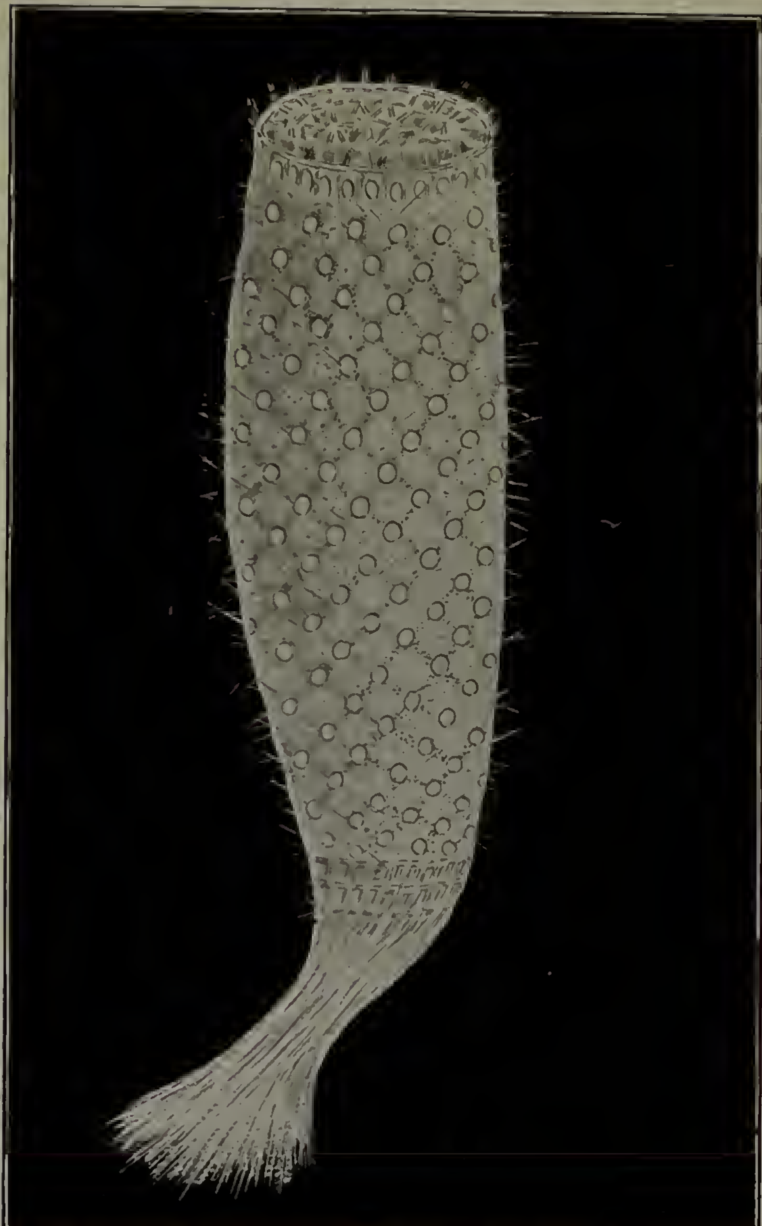

FIG. 40. GLASS-SPONGE (*Euplectella suberea*) WITH SARCODE

Wyville Thomson

CHAPTER XIV

The Hexactinellidæ

THIS is a very awkward word for the heading of a chapter, and I can only pronounce it with any satisfaction to myself by emphasising the fourth syllable—"nel." It is the scientific name of those remarkable sponges which possess skeletons or internal supports made of flint or glass, the general arrangement of which appears to be "six-rayed." They belong specially to the deep-sea fauna, and they seem to thrive best among the elements of limestone beds that are in the earliest stages of deposition.

In another little volume—*Hidden Beauties of Nature*—I have given several illustrations of *one series* of this wonderful and extensive group—*viz.* the Euplectellæ, also known as the Venus's Flower-baskets. But my remarks applied chiefly to this one series rather than to the diversified forms of the whole group. Even if a volume had been written about these beautiful objects instead of a few pages, there would still be left unsaid many things that ought to

be said in their favour. They are an ancient family, and therefore they ought to command our esteem and attention. They are beautiful; therefore we ought to admire them, as they are not susceptible to flattery.

Ever so many beautiful forms are frequently added to the great collection in the Cromwell Road Museum. An unattractive glass-sponge is unknown. Yet we see in most instances only their skeletons. If we could see the creatures themselves endowed with life, our admiration of them would be proportionally increased.

From the year 1841, when Sir Richard Owen read his epoch-making paper on the *Euplectella aspergillum*, to the present time geologists and marine biologists have taken a very keen interest in all varieties of glass-sponges which have been brought up from ocean depths. They are found at various depths from 500 feet to over 17,000 feet.

These creatures may be said to possess two skeletons of transparent flint. One is a framework built up of very fine rods which meet at various points at definite angles; and the other is composed of innumerable multitudes of spicules so small that it requires the searching power of the microscope to detect them and the beautiful order in which they are arranged. All of these give support to the

sarcode, or flesh, of the animal. Wherever modifications of the glass rods occur as to arrangement, diversity of forms in the sponge is the result. So that we have glass-sponges shaped like wine-glasses, balls, cups, horns, lamp-shades, etc.

Referring to this dual skeleton system, Sir Wyville Thomson says: 'As might have been anticipated in fresh specimens, the crystal framework is covered and entirely masked by a layer of grey-brown gelatinous matter—"sarcode," as it is technically called—and which is very thin and loaded with granules of pigment masses, grains of sand, and shells of foraminifera. Even in this slimy covering, however, there is not absent the element of beauty; for a multitude of minute siliceous spicules, which pervade it everywhere, and whose function seems to be to bind its particles together and to add to its consistency, present singularly elegant forms.'

Some naturalists consider the Euplectella the flower of the family of glass-sponges. One, *E. suberea* (fig. 40), is shown clothed in its garb of sarcode; while the illustration shown in the little work referred to represents the skeleton only.

One of the most remarkable forms of the Hexactinellidæ is the Polylophus (*Lophocalyx*) from the waters around the Philippine Islands (fig. 41, on Title-page). It shows a number of prominences on the main cup, each with glass threads

standing out straight in various directions. The threads towards the base of the large cup form tufts for anchoring the sponge in the mud in which it thrives. The 'buds' grow larger, develop oscules, or mouths; become detached from the parent sponge; and float away as young, separate, and independent sponges. A remarkable and parallel case to this is the budding process of *Hydra viridis*, a microscopic creature in our English ponds.

Young glass-sponges are also developed from sponge eggs or gemmules. Polylophus is only a few inches in diameter, but it is a lovely object. A drawing gives but a poor conception of the object itself, which may be seen among many curious members of the family in the Sponge Gallery of the Natural History Museum.

In a case close by we have a sponge, or, more correctly, seven sponges on one stem (fig. 42). It seems to be the only specimen of its kind so far. There are no duplicates of it in this collection. It was brought up from a depth of 4,950 feet in the waters near the Celebes Islands, during the voyage of the Challenger. Its name is *Esperiopsis challengeri*. It stands beautifully preserved in a glass jar with a black background, which shows it up to perfection. It is about 9 inches in height, and its colour approaches that of very pale cream.

Whenever a certain collector of glass-sponges goes to that particular department of the Museum, he always stands and admires it, and the almost covetous thought arises, 'I wish I had one like it.'

Turning to an adjacent case, we find a glass-sponge lying on its

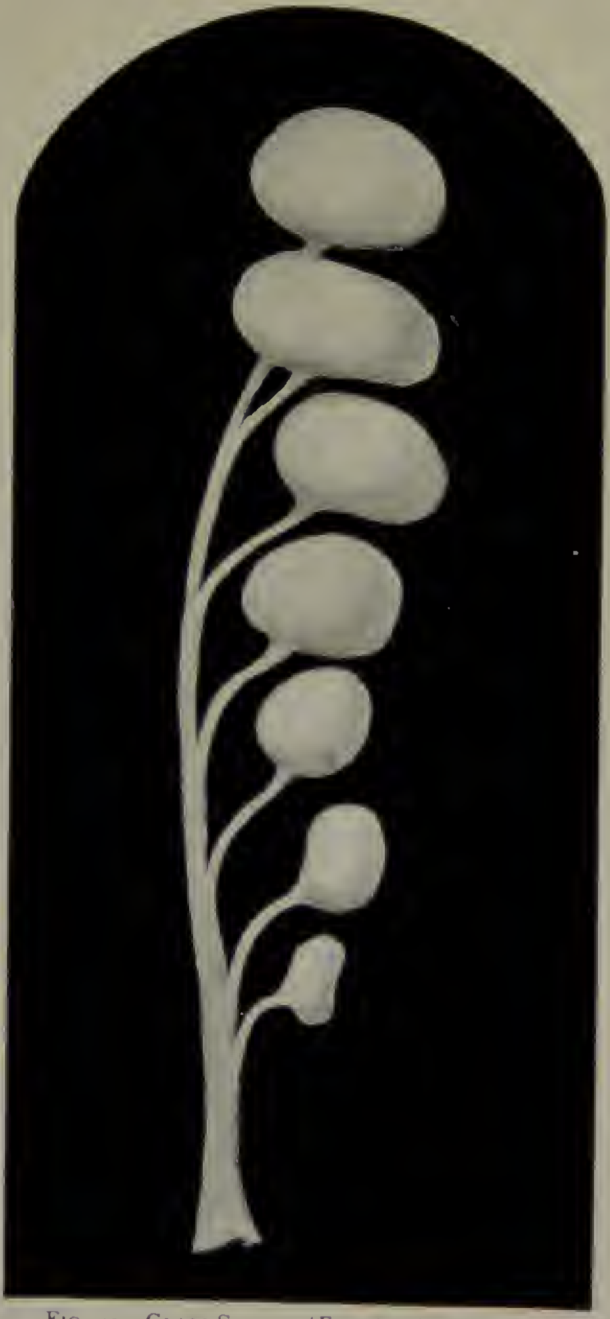

FIG. 42. GLASS-SPONGE (*Esperiopsis challengeri*)
Natural History Museum

side. Its beautiful network of glass rods is covered by a delicate net, like lacework. It is *Semperella schultzei*, and was brought up from the depths of Sangami Bay, Japan. The enveloping lace has all the appearance of the finest and most delicate handiwork that can be produced by a skilled lacemaker. It will stand good magnifying power.

The illustration (fig. 43) is from a smaller specimen, about 15 inches in length, brought up in the neighbourhood of the Philippine Islands from a depth of 600 feet.

We have in another chapter an instance where a wonderful imitation of hand-made lace is produced in the bark of a tree that grows in Jamaica. Here we have a case in which a little-known marine creature produces, or secretes, a covering like fine lace; but the material secreted is a near approach to glass.

Leaving the lace-producing sponge, we come to one whose skeleton is more like gauze, and yet the secreted material is precisely the same.

In *Farrea occa* (fig. 44, Frontispiece) we have a glass-sponge skeleton that seems to owe its attractiveness to two qualities—its unsymmetrical shape and its extreme lightness. The illustration fails to show this latter quality. To gain any idea of what this object is like, one has to imagine

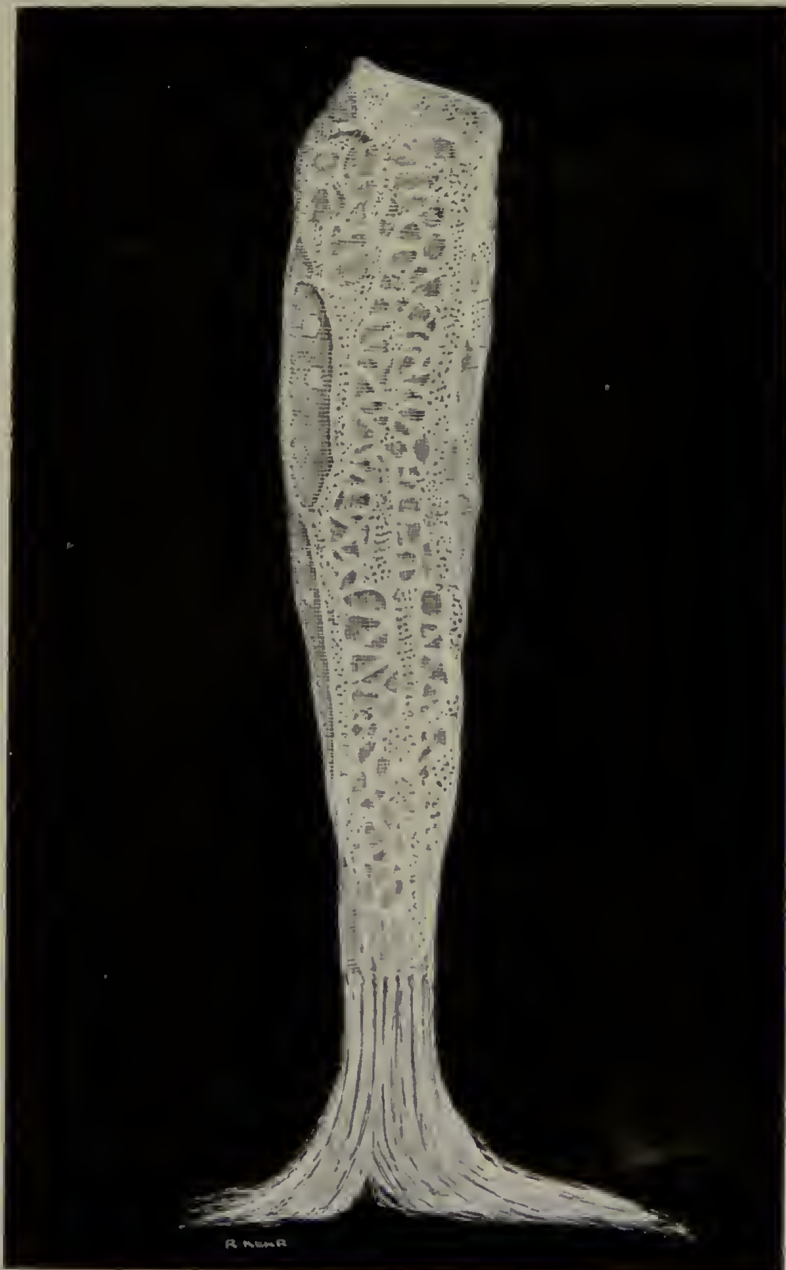

FIG. 43. GLASS-SPONGE (*Semperella schultzei*)

a series of tubes made up of spun-glass threads, light and gauze-like, closely worked, so that the meshes are extremely fine and regular.

FIG. 45. GLASS-SPONGE (*Cratcromorpha meyeri*)

After J. E. Grey

The specimen at first sight has the appearance of coral; but coral being carbonate of lime, and this being glass or transparent flint, the difference is very great. There are structural differences as well. The illustration shows only a portion of the skeleton.

The next flinty skeleton is that of Crateromorpha (fig. 45). It is so very artificial in appearance, it is hard to realise

Fig. 46. Glass-Sponges (*Hyalonema apertum* and *Lefroyella decora*)
Challenger

that it is one of the two frame-works of a sponge animal.

Two glass-sponges are shown in fig. 46. The lower is *Lefroyella decora*, a very beautiful example, but unfortunately a damaged specimen. The upper figure is *Hyalonema* (*stylocalyx*) *apertum*. It is shown in a foreshortened position, to bring into view the excurrent openings in the lid or upper covering. In all sponges the water containing food, etc., enters the sponge through the minute openings and leaves by the large mouths (oscules).

Two more specimens are shown in fig. 47. The lower is *Caulocalyx tener*, and the upper *Hyalostylus dives*. They are attractive forms of Nature's glass-work. So much like glass is the lower specimen that a friend thought it would do for a shade or bulb for the electric light or for an incandescent lamp.

The four remaining figures of existing members of the glass-sponge family belong to the distinct Hyalonema group.

Fig. 48 is *Hyalonema sieboldii*. It has a long glass-rope attachment, which is frequently covered with parasitic creatures, generally known as 'zoophytes.' It is found in the Japanese waters at great depths. Some magnificent specimens are to be seen in one of the cases of Hexactinellidæ sponges.

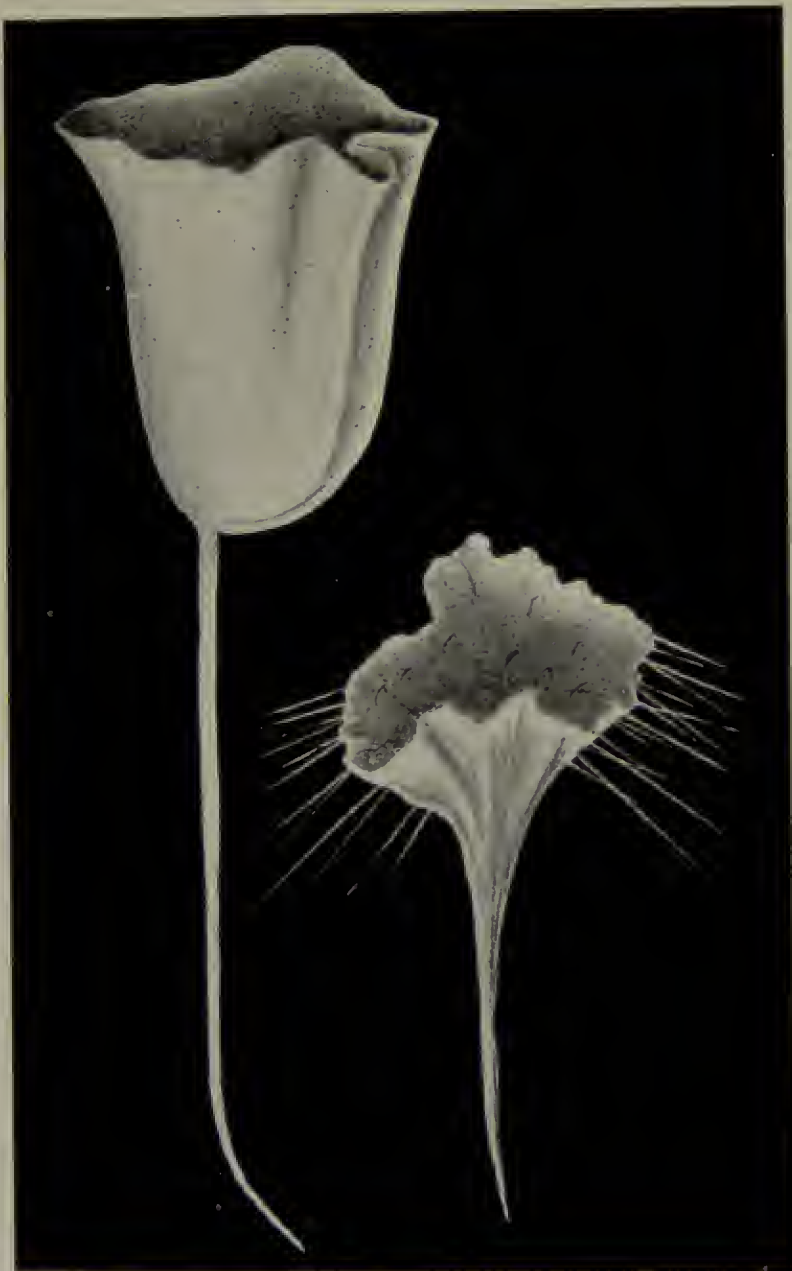

Fig. 47. Glass-Sponges (*Hyalostylus dives and Caulocalyx tener*)
After Schulze

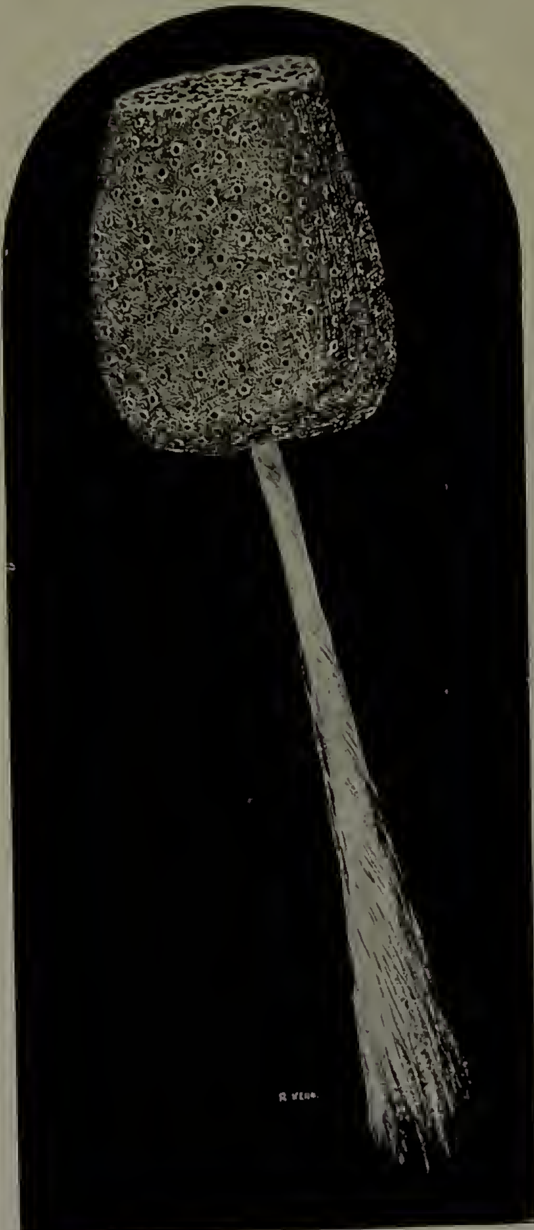

FIG. 48. GLASS-SPONGE (*Hyalonema sieboldii*)

Fig. 49 is *Hyalonema toxeres*. The glass net-work is shown at intervals. Fig. 50 is *Hyalonema divergens*, and fig. 51 is *Hyalomena conus*.

Fossil forms very much like these last are frequently found in the centre of flints and in the chalk beds.

Finding glass - sponges in the waters of Eastern seas, and subsequently in the Atlantic and Pacific Oceans,

was a discovery that threw light on the true nature of the fossil forms Ventriculites and Choanites, and was of great value to geologists

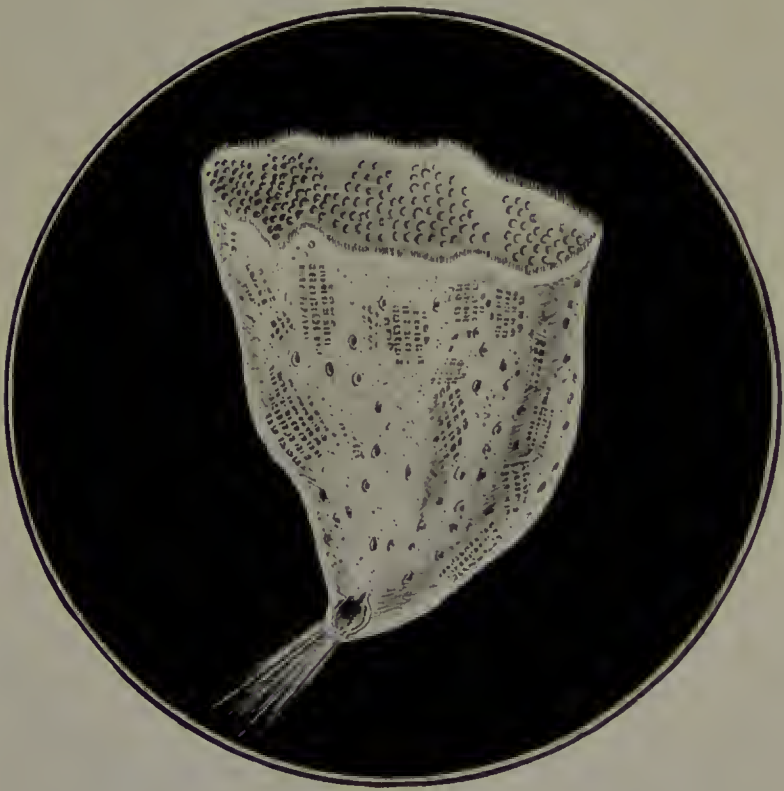

FIG. 49. GLASS-SPONGE (*Hyalonema toxeres*)

After Wyville Thomson

and biologists; and while the discovery in a general sense is of value to all students of Nature, it rendered especial service to those who were searching

for corroborative evidence in favour of the continuity of the chalk.

The three illustrations (fig. 52: see p. 9) are of fossils, and are from specimens similar to those commonly found in our own rocks.

Fig. 53 represents a fossil very common in the upper chalk of Flamborough Head. There are several examples of this beautiful fossil-sponge in the National Collection. Its name is *Verruculina reussii*. It is described as follows:—

'Sponge forming large horizontal plate-like expansions, or in the form of a shallow dish or cup, growing from a short peduncle. The margins are rounded, either even or lobed, or occasionally digitate. The oscules (mouths) are carried on the summit of small papillæ. Oscules on upper and under surfaces of sponge. The interior of the wall is composed of a labyrinth web of a very delicate network of fibres.'

As the examples are numerous and well preserved, collectors should be able to make their acquaintance when in that part of Yorkshire.

Taking into consideration the small amount of space occupied by a sponge, whether in the living or the fossil state, it is surprising the amount of surface it contains, reminding one of the convolutions of the human brain, or of a large silk handkerchief, which may show a double surface

FIG. 50. GLASS-SPONGE (*Hyalonema divergens*)
After Schulze

FIG. 51. GLASS-SPONGE (*Hyalonema conus*)
After Schulze

some square feet in area, but which may be compressed into very small compass. The cross-sections of the Ventriculites of the chalk bear a

Fig. 53. Fossil Glass-Sponge

Natural History Museum

strong resemblance to a cross-section of the brain—a resemblance arising from the simple circumstance that both are examples of a similar mode adopted

by Nature for packing an extensive surface into a small space.

Fig. 54 shows three fossil sponges (Ventriculites), also common in our English rocks.

Although the waters around our islands do not

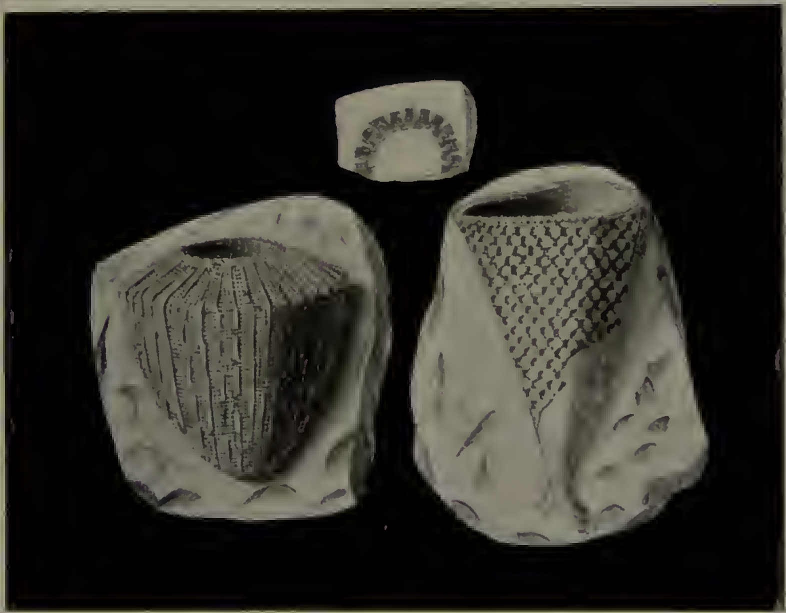

FIG. 54. FOSSIL GLASS-SPONGES (*Ventriculites*)

supply us with living glass-sponges, we have the satisfaction of being able to find, as we have seen, many varieties of fossil forms. They are in great abundance in the flint, chalk, and greensand of the south of England alone, to say nothing of those found in rocks much older. To explore the rocks

for these treasures ought to be, and is to many, a source of very great pleasure. Many beautiful specimens, showing the delicate tracery of the living examples, are daily being washed down from the cliffs into the sea, to be rolled as pebbles on the shore. Some of these are picked up at Eastbourne and other places on the south coast, and are known as Choanites. But great numbers are lost in the sea, while most of those in the more inland rocks are likely to be broken up for road-metal. It seems a pity that there are not more collectors to take an interest in these wonders, and to secure more specimens for public and private museums.

Unfortunately, collecting such objects forms an absorbing occupation to a comparatively few of the great army of holiday-makers. To those few there is a delightful fascination in the pursuit of fossil glass-sponges.

The modern collector has a great advantage over the early geologists. They knew nothing about the natural history of these fossil forms of life. But when the glass-sponges from Eastern seas were brought to Europe, the true character of this race of creatures was unfolded to the mind of the biologist; and the Ventriculites, Choanites, Fossil-mushrooms, etc., were shown to be the ancestors of the glass-sponges of our time.

CHAPTER XV

Sponge (Neptune's Cup) and Sponge-Fishing

THE most curious objects in Nature hail from the sea, and there is hardly any creature more curious than the sponge, whose skeleton we use in the bath-room. Even now we hesitate to apply to it the term 'creature,' although from Aristotle's time to the present the sponge has been looked upon as more of an animal than anything else.

Differences of opinion exist as to whereabouts in the scale of animal life it should be placed. Some naturalists put it next to the Protozoa, or first forms of life; while others assign to it a position among the hollow-bodied creatures, or Cœlenterata. Lydekker and others form for it a special sub-kingdom—the Porifera.

Sponges have no limitations as to shape and size, like other creatures. They may attain to a circumference of several feet, or may be no larger than a pin's head. There are at least two thousand species of sponges known to science.

The floors of the warmer oceans and seas are covered with an infinite variety of sponge animals. Submarine caves and ledges of rock are festooned with sponges of all imaginable colours and shapes. Some are attached to seaweeds, others to the shells of other creatures, while samples of fine texture have been dredged up attached to ancient amphora. They are generally found attached to rocks.

The sponge in its early days is a free-swimming creature, being provided with cilia, which lash the water and help its movements.

The wider holes, or oscules, in any sponge denote the outlets for the currents of water that have taken food and other supplies to the living sponge. The water, charged with sponge food and material for its structure, whether leathery, flinty, or of lime, enters by the tiny pores, and surrenders these materials in passing through the ramifications of the sponge structure.

Sponges are found at all depths and in all seas. There are a few forms, too, of fresh-water sponges, the winter eggs of which, called statoblasts, are well known to workers with the microscope. The gemmules, or sponge eggs, each showing its nucleus, of marine sponges are also prized for observation under that instrument.

Sponges grow in curious shapes. The Neptune's Cup (*Poterion patera*) of the Indian seas (fig. 55)

resembles a wine-glass, but often attains to a height of two feet or more. Neptune's Glove is a giant sponge with exaggerated fingers. Neptune's Horn or Trumpet often attains to a length of five feet.

FIG. 55. NEPTUNE'S CUP SPONGE (*Poterion patera*)

Cups, balls, fans, and discs are among the more frequent shapes, while some are not unlike life-belts of large size

We can see no possible connection between a

sponge and a silkworm; yet analysts tell us that the fibres of the toilet-sponge, when chemically examined and analysed, are found to differ very little from the silk of the silkworm. What we call sponge is the leathery skeleton of the creature; its flesh, or sarcode, was removed after it was brought up by the divers.

The sponges from the Mediterranean are the best in the world, both for fineness of texture and for durability. The West Indian sponges are not comparable with the European specimens. They are coarser and less durable. At the same time, by a process of bleaching, they are made to look very attractive. They are known as Cuban, Floridan, Bahaman, etc. The different qualities are called 'sheep's-wool,' 'grass,' and 'velvet pile.' A good 'sheep's-wool'-sponge fetches about four shillings; whereas a Turkey cup of the same size would cost twelve or thirteen shillings.

There are certain sponges which cannot secrete the leathery skeleton on the one hand, nor the flinty skeleton of the glass-sponge on the other; but they can appropriate carbonate of lime and secrete a skeleton made of that substance. The Sycetta, Sycortis, Sycometra, and Ascandra are examples of calcareous sponges. Their microscopic spicules, embedded in the flesh of the creature, are also carbonate of lime.

There are also curious sponges that are incapable of secreting any solid matter for the purposes of a skeleton, and are consequently devoid of any such organic framework. They are entirely composed of slimy matter. When they die, nothing solid remains. It may yet be shown that they are degraded forms which have lost their skeletons. They become an easy prey to many animals: shrimps and other creatures devour them; water-fleas, carried along their canal systems, are quite as ready to eat the sponge as the sponge is to eat them.

The common sponge of commerce, however, is, to all appearances, impassive to the attacks of enemies, even to backbiters of the practical kind. If fishes were to bite mouthfuls of some of them, the consequences would be more serious to the fishes than to the sponges.

Sponges form a valuable article of commerce. Over a million and a half pounds in weight of sponges are imported annually, and valued at £250,000.

Sponge-Fishing

A few particulars descriptive of the methods adopted for placing sponges within our reach will not be out of place here.

One of the best and most reliable works on the sponge of commerce and sponge-fishing is that by

Lendenfeld. I am indebted to it for the following particulars as well as for the illustration (fig. 56).

A very simple method of procuring sponges is adopted in the shallow waters on the coasts of

Fig. 56. Sponges
After Lendenfeld

Istria, Dalmatia, Algeria, Morocco, and the Bahamas. Two men sit in a boat on a calm day; and as one gently rows the boat over the sponge-grounds, the other stands in the bow, and, using a four- or five-pointed harpoon with a long handle, spears the

sponges and brings them to the surface. A slight breeze would prevent the harpooner from seeing the bottom; but to obviate this as much as possible oil is put in the troubled waters to the windward to render them smoother. This is not a good method, as the sponges are brought up torn and otherwise mutilated.

Off the west coast of Asia Minor the sponges are dredged. Bath sponges are brought up on this coast from a depth of between 400 feet and 600 feet.

Sponges which grow at depths between 60 feet and 240 feet are generally obtained by diving without a diving-dress. This is a dangerous and arduous occupation.

The diver simply provides himself with a bag over his shoulders to hold the sponges, and a large stone tied to a long rope, which he carries in his arms. He then jumps head foremost, and rapidly sinks to the bottom, owing to the stone. When he arrives below, he takes the stone under his left arm, and as fast as possible tears off as many large sponges as he can cram into his bag. Immediately, when compelled to desist by want of breath, he pulls the rope, which the men in the boat haul up with the utmost despatch. These brave fellows remain nearly four minutes under water, and return in a very

bad condition, often fainting when pulled into the boat.

This dangerous but heroic mode of sponge-fishing is now rapidly giving place to the much more satisfactory method of diving in a diving-dress.

When the sponges are brought to the surface, they very soon begin to decay; their soft parts (sarcode) liquefy, and, as a natural result in a hot climate, a dreadful stench is produced. The decaying sponges are repeatedly kneaded and washed out until the leathery skeleton is quite clean. They are then dried, packed, and shipped.

CHAPTER XVI

Curious Minerals and Rocks
Iceland Spar

DESCRIPTIONS of the nature, properties, and uses of several of the more curious and attractive rocks, precious stones, and minerals will be given in the following pages, in language that will be easy to understand.

This is a department which carries with it a degree of fascination that is only known to the student of Nature.

It has the great advantage that samples of many of the materials which constitute the solid portions of the earth's crust, including some of the gems, may be obtained without great difficulty or expense.

When such substances are classified and labelled, they form collections that are useful for reference, and are well calculated to engage the attention of all who see them, and to arouse a desire to know their nature and uses.

It is in this way that many new collectors

obtain their initial start on the road towards becoming naturalists.

In making such collections it is possible, as in other hobbies, to have extravagant tastes. Collections of costly gems may be made by those who can afford the expense; but it is possible so to systematise a number of pieces of rocks and minerals—which, if reckoned separately, would be of little intrinsic value—that they become valuable in every sense of the word. The very fact of bringing them together and arranging them in order with attached descriptions puts a value upon them.

Specimens of agate and other forms of silica had a great attraction for Mr. Ruskin. More than one museum, and several private collections, have received many of his treasures.

The late Earl of Derby was a recognised collector of beautiful stones. His collection, which he bequeathed to the Liverpool Free Museum, consists of nearly eight hundred specimens, seven hundred of which are cut and polished.

It is claimed that this is the 'most beautiful collection of cut specimens of agates and allied minerals ever made.'

For their size the precious stones are the most costly treasures yielded by the earth; but it is well to bear in mind that particulars respecting

the composition and uses of the most precious gems may not be nearly so interesting as those relating to a lump of asbestos, a piece of flint, or a crystal of apatite.

We are apt to think at the outset that because there are thousands of different kinds of rocks and minerals comprising the known portions of the solid substances of our globe, it may be next to impossible to form a fairly representative collection.

The difficulty will not appear so great if we realise that all these thousands of materials are traceable to a few elements, and that variety in outward appearance does not of necessity involve much difference in composition.

When a body—whether solid, liquid, or gaseous—cannot be divided into two or more component parts, it is said to be an element; for example, gold, mercury, oxygen.

There are only some sixty odd elements, and but a few of these are required to make up the composition of nearly all the rocks with which we are acquainted. Many of the elements are known only to scientific experts.

In looking over a collection of crystals of quartz, calcspar, iron pyrites, etc., the remark is frequently made by the uninitiated: 'How beautifully these have been cut and polished!'

There should be every allowance made for such a remark, for at times it is not easy to believe they have not received the same manipulation as that given to the diamond by a skilful lapidary.

When one sees for the first time a cube of iron-pyrites, it is hard to accept the statement of the mineralogist, that its geometrically accurate form is the result of a definite law of nature. We fancy it has been fashioned with square and compass, and for a time we are incredulous. We overlook the fact that the same Power which forms the crystals of snow is manifest in other minerals besides water, and that the symmetrical shapes assumed by certain substances in Nature are illustrations of the harmony and rhythm that pervade not only the things of earth, but the whole of the universe.

We dissolve sugar or alum in boiling water, and we allow it to cool gradually; immediately we find that an arrangement into particular shapes is taking place. Each molecule takes up its own fixed position, not in any chance fashion to form irregular lumps, but in the exact place and order necessary for the production of a perfect crystal. This is in obedience to a law, silent in its operations, which has been imposed upon certain forms of matter by the Creator. It is not life, but molecular arrangement or growth known as crystallography,

yet not growth as applied to members of the vegetable or animal kingdoms.

Neither molecules nor atoms have ever been seen, not even with the highest microscopic power; yet these small items of lifeless matter are obedient to laws as profound as that of gravitation, partly expounded by Kepler and Newton.

The saturated solutions of sugar, of alum, of saltpetre, etc., may be resolved into crystals in a very short time. But duration of time cannot be taken into account in many of the greater operations of Nature. The precious gems and the magnificent crystals we see in museums may have required great epochs of time for their formation.

The science of crystallography is arranged under six heads or systems; but it will not be necessary here to give any explanation of these systems. At the same time, if a student would excel in the study of mineralogy he must not omit this important key. There is a mystery about the formation of crystals, and an enduring beauty also.

Iceland Spar

It is not easy to realise that a rhomb of calcite (or a crystal of Iceland spar) is a perfectly natural formation. It is still more difficult to believe that an object so transparent is mainly composed of carbonate of lime; for carbonate of lime, as we

see it under ordinary conditions, is by no means transparent. The transparency is brought about in Nature's laboratory.

The same crystal has other remarkable pro-

FIG. 57. ICELAND SPAR, SHOWING DOUBLE REFRACTION

perties. Its cleavage or power of splitting in certain definite directions is so remarkable that even its microscopic particles are perfectly shaped rhombs. There remains another feature deserving

of especial notice. It possesses the property of double refraction (see fig. 57). A line or a dot seen through the crystal in certain directions appears as two lines or two dots.

A fine illustration of this is shown in a large block of Iceland spar exhibited in the pavilion of the mineral department of the Natural History Museum.

A cross is painted on one side of the crystal, which, when looked at through the specimen from the opposite side, appears as two crosses a considerable distance apart.

Pure specimens of this beautiful rock are costly and very difficult to obtain. Iceland has been the chief locality for best specimens, but the Danish Government has closed the mine, the supply becoming scarce.

In a cave near Paignton, on Torbay, some large blocks of calcite occur, which although of correct shape are unfortunately rendered opaque owing to the presence of iron so prevalent in Devonian soils. Hence there can be no double refraction observed in these specimens.

CHAPTER XVII

Remarkable Varieties of Quartz

QUARTZ may justly be said to be the most important substance in the material world; and therefore it is deserving of especial notice. No substance enters more largely into the composition of the solid structure of the earth than silica (quartz). Its distribution extends to all parts of the world, and it forms not only individual mountains, but chains of mountains many miles in extent.

It is the chief constituent of the sands of the seashore, of the sand-hills far removed from existing seas, and of the sands of the trackless deserts.

Beds of flint, the flint nodules found in chalk cliffs, many crystalline rocks, sandstones, ironstones, and the 'unnumbered pebbles' of Chesil Beach at Portland, and of thousands of other beaches, are chiefly composed of quartz with colouring matter, generally iron.

Even the meteorites that reach our planet often

contain silica in a pure state. Clayey and earthy soils, granite, and many other rocks contain silica, either in mechanical or chemical combination.

The glass used in a thousand forms and ways is a product of silica. The lenses for spectacles

FIG. 58. CRYSTALS OF QUARTZ

and other optical appliances are made from clear quartz crystal (fig. 58).

In one form or another we shall find that silica is used in many of the arts and manufactures. Looking at silica in another form, we find it in mechanical combination with iron.

The mass is pulverised and melted in a furnace, so that the pure iron leaves the furnace by one outlet and the molten silica or slag by another.

For years this slag was used for garden boundaries and rockeries, etc.

Afterwards it was found that if the molten slag were operated on by jets of steam, it would be suddenly changed into a flocculent mass, possessing properties useful in many directions. It is known as 'Wool Silicate,' and is used as a non-conductor of sound vibrations and of heat. It is, in fact, a rival of asbestos. It is cheap, easy of manipulation, and can be adapted in a variety of useful ways. It resembles wool, but is heavier; but owing to the fineness of its fibres it is not wise to handle it, as it irritates the skin. Builders use it largely.

Many hosts of marine creatures are dependent upon silica for their homes, shells, or skeletons—*e.g.*, the glass-sponge tribe, and the Radiolarians of ocean warm waters, etc.

Among plant life, too, are the myriads of diatoms whose microscopic boxes, beautifully decorated, are entirely composed of silica. Their skeletons accumulate to immense depths, and form the foundations of cities, as on the east coast of the United States.

The superior kinds of flints were used in prehistoric times for weapons of offence and defence. The most ancient are called Palæolithic, and those showing an advance in civilisation are termed Neolithic. Axes, hammers, arrow-heads, javelins,

and many other weapons and tools were made of flint long before the use of metals was known.

Only a few out of the many uses of silica have been noticed; but it is evident that silica is a most useful mineral, if not the most useful, because of the great number of forms it assumes, the number of substances it combines with, and those which it replaces.

In preparing a world on which man was destined to take up his abode, the Creator foresaw that He would need certain rocks for definite purposes, and through the long ages of the past all these wonderful things were undergoing processes of preparation for our use. The adaptability of these substances to our special requirements is in itself an evidence of supreme design.

Before describing briefly several of the 'glittering treasures of the earth,' which are mainly dependent on silica as their chief constituent and the source of their beauty, we must give a passing thought to Professor C. V. Boys's wonderful use of quartz.

When about to ascertain the weight of the earth, he required for his experiment an extremely fine thread, capable of enduring a considerable strain, and possessed of other necessary qualities. Gold wire and silk threads, however fine, were useless, even the spider's web, so useful to the astronomer, as a fine micrometer in delicate

measurements, was not equal to the demands of the learned Professor; but fibres of quartz, drawn out to microscopic fineness, enabled him to carry out his extraordinary sensitive experiments, so that he was successful on all points; and his results are more accurate than those of any of his predecessors in this particular line of physical research.

Many of the less costly, but very curious and beautiful, stones are only different varieties of quartz—a combination of silica and oxygen.

When this rock is permeated with traces of iron, manganese, and other substances, it constitutes a large variety of beautiful specimens. Among the number are quartz-amethyst, cairngorm, avanturine, Brazilian ruby, the Western topaz, chalcedonies, onyxes, agates, moss agates, jaspers, bloodstones, geodes, etc. (fig. 59).

Quartz, the crystal of the ancients, the rock-crystal of modern times, and the Brazilian pebble of lens-makers, is composed of about forty-six parts of the element silicon in combination with about fifty parts of oxygen. Magnificent crystals of quartz have been brought from Japan and Madagascar.

From the latter island crystals have been obtained that are transparent and pure, although quite a foot in height. A single crystal now in the New York Museum weighs 212 lb., is 30 inches high, and 12 inches in diameter. It is

perfectly formed throughout. In a museum in Paris is a crystal of quartz 3 feet high and 3 feet wide. It weighs 800 lb. In the Guide

Fig. 59. Potato-Stone (Geode)

to the Naples Museum mention is made of a group of remarkably fine crystals of quartz, which, in the mass, weighs nearly half a ton. Fine crystals are also found in the Alps.

The Onyx and Chalcedony are banded agates of different colours, and have been selected by cameo and intaglio cutters for some of the finest masterpieces of engraving. (See article on Cameos.)

The Agate was said to have been found on the banks of the River Achates in Sicily, hence the origin of its name. It is by no means a rare stone, as good specimens are obtained from Oberstein, India, Brazil, Scotland, Iceland, etc. The agate can be sawn or cut, and worked on the lapidary's lathe, and made into cups, rings, seals, handles for knives, etc. Many of the objects made from it are valuable and beautiful.

Moss Agates and Mocha Stones are clearer varieties which approach the purity of the chalcedony. They contain clouds, dashes of rich brown of various shades, and representations of moss foliage. Bushes, trees, moss, and even landscapes are figured by Nature in bold characters in many of the specimens. An analysis of the substances which give rise to these dendritic forms shows them to be oxide of iron, and the mineral psilomelane But there are instances in which the actual moss is silicified in the centre of the stone (fig. 60).

All such forms are of great interest, and give a special value to the specimens.

Jasper is a coloured and very compact quartz. It may be red, yellow, brown, green, grey, white, or black. Iron in one form or another gives

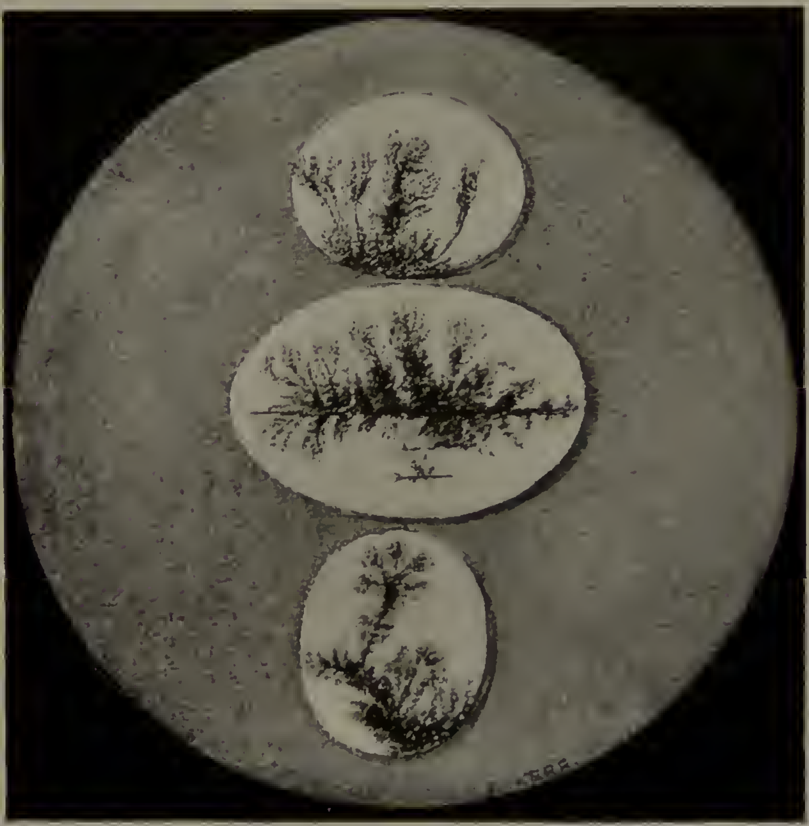

FIG. 65. MOSS AGATES

it its colour when red, yellow, or brown. Some kinds are spotted, other have veins or bands. The Egyptian Jasper is always easily recognised owing to the appearance of ribbons, which are

very pronounced when the stone is cut and polished.

Jasper is found in many countries—the blood-red in the Northern Apennines, and at Baden, and in Scotland, etc. The Yellow Jaspers are found chiefly in the Ural Mountains and in Egypt.

Chalcedony is a translucent variety of quartz. It is found in the form of stalactites and in masses with a curved leafy structure. It often replaces animal forms in rocks and lines cavities in flints with mammillary crystals. Fine varieties are found in Cornwall, Oberstein, Scotland, Hungary, etc. Very frequently it forms what are known to geologists as pseudomorphs. That is, it takes the place of fossil shells, crystals of fluor-spar, sponges, etc. Such pseudomorphs, or "false shapes" in chalcedony are much prized by collectors.

Carnelian, a flesh-coloured stone, as its name implies, is chalcedony coloured blood-red. But the name is also given to yellow and brown specimens. The finest come from Siberia, India, Arabia, and Surinam.

Chrysoprase is an apple-green variety of chalcedony. Its chief home is at Vermont in North America and in Silesia.

Heliotrope is a dark-green form of quartz sprinkled with deep red spots, to which it owes the name 'Bloodstone.' It is found in Siberia, Bohemia, Scotland, etc.

Onyx, another of the quartz or silica family, is a beautiful stone with alternate layers of white, brown, or black. It was much used in ancient times for cameos. (See article on Cameos.)

Opal is another variety of quartz, and is a very beautiful rock. The noble opal is translucent with brilliant prismatic colours, which Brewster says are caused by minute pores in the mass, and not by cracks or fissures. The finest specimens in recent years have been brought from Queensland and Tasmania.

A specimen in the mineral collection of the Natural History Museum seems to have replaced the bone of an animal. Each surface of the fractures of the apparent bone shows the beautiful play of colours so peculiar to the precious opal.

The Cairngorm of Scotland, so much prized for brooches and other ornaments, is a smoky quartz rock. When large, dark specimens are cut and polished they fetch from a pound to five pounds

apiece. Some rich amber-coloured specimens are often mistaken for the topaz.

The Amethyst is a violet-blue variety of quartz. It looks better in daylight than at night-time. Sometimes the amethyst has a deep purple tint. The superstitious believe that wearing it insures peace of mind.

Avanturine is a rich brown, opaque quartz, glittering with mica or golden spangles in minute form within its substance. It is found in India, Spain, Scotland, etc. Very often it is imitated for brooch material.

The thirteen or fourteen stones so briefly considered are all beautiful, and yet the chief ingredient in their composition is quartz (silica). A little alteration in the amount of quartz or the addition of some colouring matter, and the whole appearance of the stone is altered. A great variety with a minimum of change in the composition is wrought out in Nature's laboratory. The result is a beautiful collection of specimens.

CHAPTER XVIII

Petrified Trees and Flexible Sandstone

IT seems incredible that whole forests of splendid trees have been petrified, or, more strictly, 'silicified'; that what was at one time a large collection of trees, filled with sap and endowed with life, is now classed with the mineral kingdom; that the change has been so perfect, and yet brought about without any visible alteration. If one did not handle the specimens to test their hardness, weight, or change in temperature, it would be impossible in many instances, by eyesight alone, to detect the alteration.

The substance, silica, which we noticed in a former chapter as playing so important a part in the composition of certain beautiful stones, under favourable conditions enters into the minute cellular structure of wood, and works a result that is beautiful and astonishing.

At the Paris Exhibition of 1889, sections of

large trees so transmuted were among its chief attractions.

Transverse sections of silicified wood were polished, showing all the details of exquisite tracery and natural structure, standing the power of the microscope, and, in fact, only displaying their full beauty when viewed through that instrument. Here were agates, jaspers, chalcedonies, amethysts, and yet sections of wood of pre-historic times. The vegetable texture in all its details replaced by silica and coloured in every shade of red, brown, yellow, green, etc. The sections exhibited were intended as tops for tables (fig. 61).

These specimens were obtained from the wonderful silicified forest of Arizona, U.S.A. This is undoubtedly one of America's greatest wonders, for the giant trees of a thousand acres are much more wonderful now than before their transformation. As a decorative material, possessing great beauty and durability, it is unrivalled. Beautiful trunks and branches of silicified wood are also found in the island of Antigua and in the countries west of the Andes in South America.

Darwin came across one of these silicified pine forests, and his description and explanation of the phenomenon will enable us to understand how such marvellous changes are brought about; while it will open our minds to a wider view of the history of

our globe, and the time required for such a mighty alteration to take place:

'It required little geological practice to interpret the marvellous story which this scene at once unfolded; though I confess I was at first so much

FIG. 61. SECTION OF SILICIFIED WOOD AS A TABLE-TOP

astonished that I could scarcely believe the plainest evidence of it. I saw the spot where a cluster of fine trees had once waved their branches on the shores of the Atlantic when that ocean —now driven back seven hundred miles—ap-

proached the base of the Andes. I saw that they had sprung from a volcanic soil which had been raised above the level of the sea, and that this dry land, with its upright trees, had subsequently been let down to the depths of the ocean. There it was covered by sedimentary matter, and this again by enormous streams of submarine lava—one such mass alone attaining the thickness of a thousand feet—and these deluges of melted stone and aqueous deposits had been five times spread out alternately. The ocean which received such masses must have been deep; but again the subterranean forces exerted their power, and I now beheld the bed of that sea forming a chain of mountains more than seven thousand feet in altitude. Nor had those antagonistic forces been dormant, which are always at work to wear down the surface of the land to one level; the great pile of strata had been intersected by many wide valleys, and the trees now changed into silex were exposed projecting from the volcanic soil now changed into rock, whence formerly in a green and budding state they had raised their lofty heads.

'Now all is utterly irreclaimable and desert; even the lichen cannot adhere to the stony casts of former trees. Vast and scarcely comprehensible as such changes must ever appear, yet they have all occurred within a period recent when compared with

the history of the Cordilleras; and that Cordillera itself is modern as compared with some other of the fossiliferous strata of South America.'

(DARWIN'S *Voyage of the Beagle.*)

With regard to the agatised wood of Arizona, the following paragraph from *The Globe* of May 11, 1901, contains an excellent summary that will be helpful :—

'An interesting exhibit has just been set up in the mines building of the Buffalo Exhibition. It is that of the agatised wood specimens from Chalcedony Park, Apache County, Arizona. These specimens consist of cross-sections of trees, polished to a high degree of brilliancy, and showing the most beautiful colours. In some of the specimens the petrified bark still surrounds the section of the tree. This petrified forest looks more like a stone-quarry than a forest, as the pre-historic trees are mostly strewn around in broken sections. . . . It is generally conceded that Chalcedony Park was a tropical wood, transformed in a pre-historic age from a living, growing forest to the present recumbent sections of interblended agate, jasper, jade, calcite, amethyst, etc.'

Flexible Sandstone

A large slab of this sandstone several inches in thickness may be bent to a considerable degree.

For this reason it has been selected for a place among the various objects described in these pages as being curious. As this property of flexibility in a large stone is quite unexpected on our part, and quite contrary to the usual behaviour of

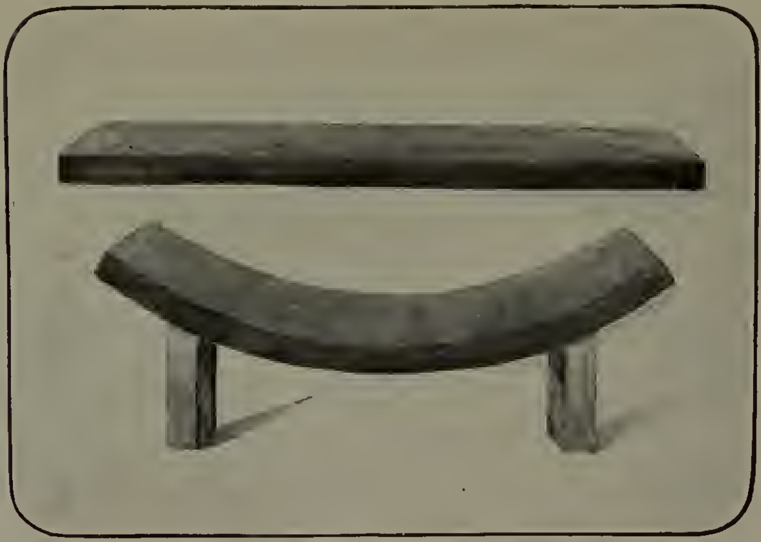

Fig. 62. Flexible Sandstone (*Itacolumyte*)

stones from the quarry, its claim to be reckoned curious appears to be fully established.

Thin sections of many stones are capable of being curved somewhat out of the horizontal position, but a block of this sandstone as large as an ordinary tombstone is capable of a surprising degree of curvature. In fig. 62 the upper sketch

shows the position of the sandstone lying on a table ; but if the stone be raised up and placed on the supports, as shown in the lower figure, it bends considerably.

There are several large slabs of this rock in the Mineral Department of the Natural History Museum, one of which is the gift of the late Mr. Ruskin. One of these specimens is supported at the ends on two cords depending from the top of the glass-case, and it is perceptibly bent, owing to its own weight.

The rock was first noticed in the quarries on Mount Itacolumi, in Brazil, and from this fact it is known as Itacolumyte, or Itacolumite. It has also been found in considerable quantities and of superior texture in North Central India. It can be sawn almost as easily as wood.

The flexibility is said to be owing to the presence of thin plates of white mica. If the plates of mica were lengthened out, we could the more easily understand the flexibility, but they are so exceedingly small that it requires the aid of a microscope to see them distinctly.

The composition of the stone is of a very simple nature—namely, minute grains of limpid quartz-sand and these tiny particles of mica.

CHAPTER XIX

Apatite and Weaving a Stone into Cloth

WHAT shall we think of a stone that gives an appetite to the invalid, that contains nutriment, and which under proper conditions enriches the growing corn that satisfies the appetite it tends to produce?

Many of the gems and ordinary rocks in olden times were said to possess qualities and properties that were most extraordinary.

But chemical analysis, the blowpipe, and common sense have proved that such mysterious powers are absent from precious stones, as well as from the commoner materials of the quarry, the mine, and the field.

For instance, the hyacinth-stone was said to preserve its possessor from disease and from lightning, to enrich his possessions, to strengthen his heart, and to make him generally happy. To this day a certain superstition exists as to the possession of an opal.

But, leaving superstition aside, we shall find, in most cases, that truth is stranger than fiction.

To return to the rock 'apatite.' The qualities this rock possesses having been fully tested, it is amply qualified to absorb a share of our attention.

There is at the outset one circumstance connected with this stone which is at least remarkable, but it can only be classed as a very unusual coincidence. Its name is uncommonly like 'appetite,' in that it is 'apatite.' The two words have no connection whatever except in appearance and sound. They have not even a common origin, and their respective meanings are unlike.

Our English word 'appetite' is derived from a Latin word that means a natural desire or hunger, whereas the name of the mineral comes from the Greek word 'apatao,' to deceive.

Owing to the variability of its lustre and colour, it was frequently mistaken for other minerals, such as fluor-spar or beryl. Some specimens are transparent, others are blue, green, red, yellow, or grey, so that they might readily deceive an inexperienced mineralogist, who, without taking the trouble to analyse the specimen, would hastily form a judgment by external appearances. Hence the name 'apatite,' or the deceptive stone.

As regards its composition, its chief ingredient

is phosphate of lime to the extent of ninety-two per cent.

In the bones, teeth, and ligaments of animals phosphate of lime is an ingredient to the extent of nearly sixty per cent. This fact led geologists to the conclusion that beds of apatite must have a close connection with fossil animal remains. Subsequent experience has substantiated this opinion.

From the nature of its composition, this rock is a boon to farmers, as it forms an excellent stimulant to put on the land.

To render it perfectly soluble, so that it may enter into the soil, the rock is reduced to powder, and is then acted upon by sulphuric acid. This renders the phosphoric acid soluble in water. Hence it is readily absorbed by the plants. It fertilises the soil, and enriches the quality of the corn. It is known as 'superphosphates.'

Unfortunately it has not been found in very large quantities in England, yet a fair supply has been obtained at Llanfyllin in North Wales. It is also found in Saxony and Spain. The greatest supply is, however, obtained from the United States and Canada (fig. 63).

So far, we see how it is serviceable to the agriculturist. We must next see as to its appetising qualities.

The chemist is able to extract from this rock an item of commercial importance, which he calls 'hypophosphites,' or 'syrup of hypophosphites.'

Fig. 63. Crystals of Apatite

Several other substances enter into the composition of this syrup; but it is understood that apatite is the great active principle, in that it contains so much of the bone-forming phosphates.

In fact, hypophosphites and superphosphates are derived from the same rock.

The same rock gives an appetite, supplies nutriment, and adds to the soil those qualities which make the corn very much better than it would be without it. This is one of the many instances we have of certain naturally formed substances exactly meeting the needs of human beings.

Doubtless, as knowledge advances, Nature will be found to supply many products, now unknown, that will administer to our good in various ways.

It is not at all unlikely that for every disease to which we are subject there lies the remedy or the antidote in some mineral or plant. But, differing from our ancestors, we shall not be satisfied with opinions as to the mythical virtues of tangible things. Everything must be brought to the test. But before Nature gives up the secrets she possesses, she must be studied with patience and with perseverance.

Weaving a Stone into Cloth

Yes, even lengths of cloth, that may be purchased by the yard or by the pound, a cloth, too, that is fireproof and that has many other valuable qualities.

The whole of the rock may be pulled out into

long shreds, and treated by machinery as if it were wool, flax, or cotton. This is an industry that was known more than two thousand years ago.

We have many discoveries and inventions to place to the credit of the nineteenth century; but the most we can say of our applications of the uses of asbestos is that they are re-discoveries, or, in fact, that we have taken a hint from, and have only copied, the work of the ancient Greeks and other nations.

Let us examine for a moment a miscellaneous collection of the raw materials and of manufactured articles all relating to asbestos. First, there is a heavy, stony-looking substance which shows a fibrous texture, then a handful of what at first sight appears to be cotton-wool, next we have a heap of similarly soft material but bluish in colour, then rolls of yarn, both coarse and fine, some pieces of strong cord, a piece of well-woven cloth, some flat rings, ropes of various thicknesses, millboard, a pair of thick gloves, etc.

Thirty years ago it would have been impossible to collect together such an array of manufactured articles; but if we look at the history of certain ancient peoples of two thousand years ago, we shall find that they manufactured cloth from asbestos, and used it for winding round the bodies of the dead previous to cremation in order that the ashes

of the body should be kept separate from those of the fire. In ancient temples asbestos wicks were used in the lamps to keep up a perpetual flame without being consumed.

It was known to the ancients under the name of 'Amianth' or 'Amianthos,' from the Greek word 'Amiantos' which means *undefiled*, and implies that it cannot be permanently defiled.

Asbestos woven into cloths for domestic uses, or for mules' saddle-cloths, when thrown into the fire gave up their impurities, and came out of the fire purified and uninjured.

It is a wonderful fact that a heavy mineral can be woven into cloth, but it is more wonderful still that it is inconsumable. It is a non-conductor of heat, it is not melted, nor altered, nor destroyed by being heated, neither can it be fused by any ordinary intense heat. Still further, it resists the action of acids and alkalies, and even the fumes of acids. It is practically rot-proof, and is imperishable by decay. It seems to defy the action of fire and of time.

Our brave firemen's gloves, ropes, and other fire-escape appliances are made from asbestos.

The natives of Greenland at the present time use it for wicks for their lamps. With us it is used for gas-fires, for fire-resisting layers under floors of buildings, for a non-conducting composition, for

putty and cement, and even for filtering acids. It is invaluable, too, as a cloth for furnacemen's aprons, overalls, leggings, and gloves. It can be made into fire-proof tape, rings, powder, paper, felt, and as a strong cloth woven with strands of wire it makes fire-proof tents. As a cloth, too, it serves as a lining for safes (fig. 64). Engineers value it as packing for engines of high or low pressure, and as a jointing material in machinery.

The cloth can be rolled, either with or without an india-rubber core, and made into fire-proof ropes. When woven with strands of fine brass wire it is most essential as a high-pressure packing for marine triple and quadruple expansion engines, and is used in the form of a jacket. Its lustre in the carded stage gives it a close resemblance to wool; while its fibrous texture, toughness, flexibility, and fire-resisting properties render it one of the most useful minerals known to science.

That such a valuable mineral should have lain for ages within reach and neglected is a striking fact. For many centuries no one seems to have had the discernment or skill to perceive its usefulness and worth. Like many other substances, it was looked upon as a curious rock or mineral, but was ignored as regards value in relation to the arts or industries. It has only been found in very large quantities in three parts of the world—

Canada, South Africa, and the area about northern Italy.

The supplies now obtained from the Tyrol are

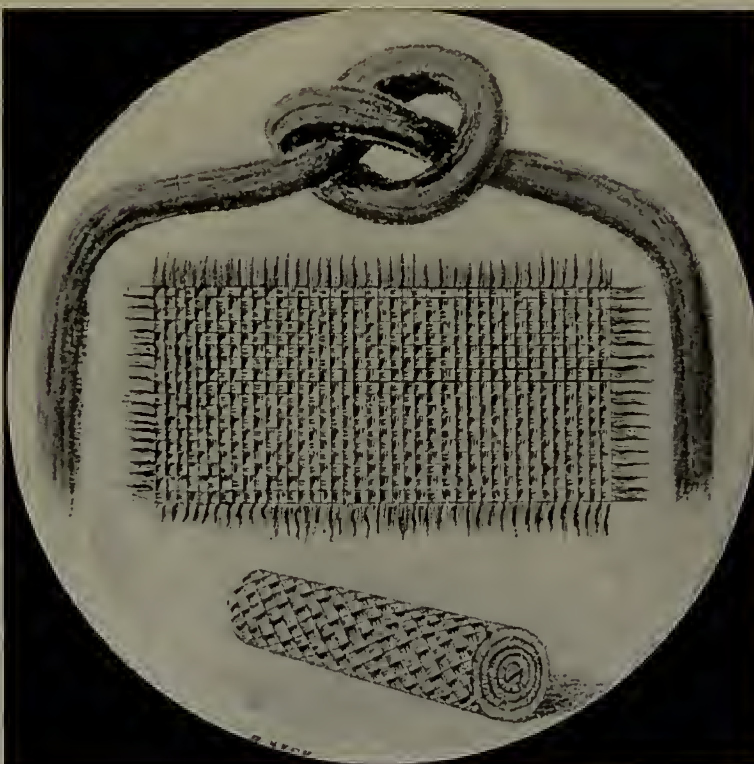

FIG. 64. ASBESTOS

insignificant compared with those from the Cape and from Canada. In fact, the asbestos trade of the world mainly depends upon the raw material sent out from these two localities. When crushed

and carded, that from Canada is white, while that from the Cape is blue.

The supply of this wonderful mineral is likely to last for a long time, inasmuch as it is deposited in an area of more than thirty thousand acres in South Africa, the property of the Cape Asbestos Company, and the famous asbestos mines of Thetford in Canada seem to have an inexhaustible supply. These mines are the property of Bell's Asbestos Company. To the genius and foresight of Mr. Bell, the founder of this firm, is due the credit of discerning the true value of this mineral.

For the sake of the young student of mineralogy the following chemical analysis is given :—

Silica	=	59	100
Magnesia	=	21	
Lime	=	14	
Water	=	2	
Protoxide of Iron	=	3	
Colouring Matter	=	1	

CHAPTER XX

Amber

IT is a remarkable fact that, although at least 2500 years have elapsed since the first electrical experiments were performed, no advance of any importance was made in the science of electricity until the century just ended. About the year 640 B.C. Thales was born at Miletus. This famous astronomer, who mathematically fixed the revolution of the earth around the sun at 365 days, and who was the first to predict a solar eclipse, records the fact that amber when rubbed attracted light bodies.

This remote and simple observation of a most elementary experiment is the foundation of the modern system of electricity, which is revolutionising motor-power and methods of illumination, and which is revealing to us other hidden forces of Nature.

The word *electricity* is derived from *electron*, the Greek for amber, and one of the names of the sun-god.

This fossil resin, then, stands at the head of the long list of electrical apparatus and resultant experiments, which include even the new means of transmitting messages through space without wires.

But amber was mentioned and valued at a still earlier date—*i.e.*, if Homer ever had any real existence, which some doubt.

The poor, blind poet that recited his verses for bread was acquainted with amber nearly two hundred years before the days of Thales.

He says in the *Odyssey* that 'Among the jewels offered by the Phœnician traders to the Queen of Syra was a gold necklace hung with bits of amber.'

Some of our museums and private collections contain large-sized amber vessels which have come down from ancient times, and which have often puzzled those who are aware that large masses of amber are of extremely rare occurrence. Such vessels are very greatly prized on account of their bulk and purity (fig. 65).

But the ancient artificer in amber may have been aware of the following facts. If so, the cherished notions as to the bulk of the masses of amber requisite for large vessels so highly valued must necessarily receive a palpable shock.

If small pieces of amber be boiled in rape oil

for twenty hours, they will cement and mould together; or if they are placed in an iron pot, then covered with sand and exposed to the influence of heat for forty hours, the same result will follow.

Manifestly it is not advisable to pay great sums for large vessels made of amber.

The Prussian sea-board of the Baltic is the great source of the amber supply in Europe. In Asia large quantities are found in the northern districts of Burmah.

Nero sent an expedition from Rome to explore the amber-producing countries, and so successful was the party that a present of 1,300 lb. of amber was brought back.

The value of amber depends upon its bulk and its colour. The most beautiful specimens in the world are found at Catania. The amber from this district presents a play of colour approaching to purple.

In 1576 a piece weighing 11 lb. was found in Prussia, and deemed worthy of being presented to the Emperor.

It is recorded that a sum of $5,000 was refused for another piece weighing 13 lb., and that the Royal Cabinet of Berlin contains a block weighing 18 lb.

Pliny, whose thirty-seven books of *Natural*

History form one of the most precious monuments of antiquity extant, knew that 'amber was an exudation from trees of the pine family, like

Fig. 65. Cups of Amber

Natural History Museum

gum from the cherry, and resin from the ordinary pine.'

Amber of course differs from other resins owing

to changes induced by its fossilised condition. The remains of plants and insects found enclosed in amber belong, for the greater part, to extinct species.

It was thought that a species of conifer, *Pinites succinifer*, was the only tree that yielded amber; but Goppert has shown that at least eight species of plants besides *Pinites succinifer* have afforded these fossilised resins, and he has enumerated 163 species as represented by remains in them.

There can be no doubt whatever that amber is of vegetable origin. This is fully proved from its native situation, and from the occurrence of insects embalmed in it. That it was once a viscous fluid is evident from the fact that repeatedly legs and wings of insects are found some distance from the bodies, which had been detached in the struggle for freedom.

The great difference between resins and amber is, that the former contain little or no succinic acid, whereas this acid is present in amber to the amount of six or eight per cent. The ancient Egyptians, although skilled in scientific methods of embalming, knew of no process so perfect or so simple as that of Nature.

Entomologists are indebted to the perfection of Nature's process for information respecting insect life of the remote past.

Botanists, too, become acquainted with extinct forms of plant life preserved in perfect detail. Twigs, flowers, leaves, buds, stamens, pistils, sepals, petals, and even the most delicate tissues of vegetation of ancient periods are beautifully preserved in amber.

From the earliest historic and even from prehistoric times amber has been held in popular regard. The most ancient tombs known to antiquaries contained amber ornaments. The Neolithic (or New Stone Age) Museum at Copenhagen contains many beautiful specimens of amber wrought into beads, which were worn by people of whom we have no written record. Associated with these ornaments were implements, weapons, and utensils of bronze, found in the Danish peat-bogs. Doubtless a superstition as to its properties greatly enhanced the value of amber.

In Greek legends we are told that the Heliadæ, on seeing their brother Phæthon hurled by lightning into the Eridanus for presuming to drive the chariot of the sun-god Electron, were changed into poplar-trees, and the tears they shed dropped as amber on the banks of the river. In old times amber was thought to be a charm against witchcraft; and several medicinal virtues were ascribed to it.

Great quantities of amber are purchased to be consumed at the shrine of Mahomet by the pilgrims

bound to Mecca. The Turks value it for mouth-pieces for tobacco-pipes, believing that it resists the transmission of infection.

We may form an idea of the value of human life at the beginning of the Christian era by a remark made by Pliny, 'that the price of a small figure of amber, however diminutive, exceeds that of a living, healthy slave.' For the sake of those who may wish to know more of the details about amber, it will be necessary to consider its geological position.

On the German sea-board there are mines about 100 feet deep where the amber is found associated with bituminous wood and parts of trees impregnated with iron pyrites. The bed containing the amber is of a blackish brown colour, and is about 50 feet in thickness.

Owing to the nature of the overlying strata and to the fact that many of the insect and plant remains are extinct, we must come to the conclusion that amber belongs to a considerably remote period.

After heavy storms in the Baltic large quantities are found along the coasts.

Amber is also found in several parts of France, in Switzerland, and in England. It has been found in the clay deposits of Kensington, and in or under the forest-bed of Cromer.

Amber is tasteless, and, at a normal temperature,

is without smell. It begins to soften if heated to about 150°, and finally melts between 250° and 300°. It burns with a pale-yellow flame, gives off a great deal of black smoke and an agreeable odour, and leaves a shining black powder.

When dissolved in certain spirits, amber makes a splendid varnish. Fine pieces containing insects or plants are always in demand for collections. Among Oriental nations good pieces are carved into ornaments; but the western nations use it for mouthpieces for tobacco-pipes and cigar-holders—an ignoble use, to my mind.

CHAPTER XXI

Felspar

IF our ancestors had been good chemists, or even if they had been familiar with the composition and uses of the rocks of our own country, the nation would not have remained for so many centuries in absolute ignorance of the manufacture of chinaware (porcelain), or of the superior kinds of pottery.

For many centuries the Chinese kept to themselves as a profound secret the nature of the substances with which they made the exquisite productions called after the name of their country. In this they were perfectly justified, but it does not redound to the credit of the people of these islands during that lengthened period.

All along those centuries England had equally good materials lying unused, ignored, and looked upon as absolute waste. Instead of losing time and money in trying to produce gold from the baser metals, if they had been able to analyse china clay,

they would have found certain quarries in Cornwall, which, if worked, would have produced the gold they were seeking, but not in the way expected by the alchemist.

There were several granite quarries which for ages had been looked upon as worthless for building material because the granite was decomposed. These very quarries in later times proved to be much more valuable than if the granite had been solid and enduring. This rock consists of quartz, felspar, and mica. When the felspar decomposes, the granite falls to pieces. In its decomposition the felspar undergoes a change. The alkali, potash, is removed with part of the silica, while it takes up water. The felspar thus changed is the material used in the manufacture of chinaware, and is called kaolin.

Exposure to the atmosphere in the course of time will bring about the alteration in the felspar. In some localities it is ground to a powder, and produces a fine clay when mixed with water. Roughly speaking, this composition consists of sixty parts of silica and forty of alumina. The finest porcelain, pottery, statuettes, and even artificial teeth are manufactured from this altered felspar.

In Cornwall, where the preparation of kaolin is carried on, the streams are as white as if all

the dairies had lost their milk supplies. About ten thousand tons of the finest china clay, and about thirty thousand tons of the ordinary kind are prepared annually and sent off to The Potteries. Occupation is thereby given to a great number of people, and as the process of further manipulation proceeds at The Potteries, a still larger number find employment in bringing the crude clay to an artistic and useful condition. There can hardly be a house in the kingdom, possibly not one in the civilised portions of the globe, which is not dependent upon this very manufacture for some ornament or set of vessels used for culinary purposes.

When extra care and great taste are brought to bear upon china clay, objects of immense value are produced. Many valuable vases and china tea-services made in England have been thought by many to be equal to any ever produced by the Chinese.

It is said that a tea-service made in England by the firm of Copeland (formerly Spode) was given by Mr. Copeland as a wedding present to the Prince and Princess of Wales (the present King and Queen). This set is a great work of art, and is valued at £1,000.

The best porcelain in China is said to be made at King-te-tcheng. This town has furnished

the Emperors of China with porcelain since A.D. 442.

Porcelain and pottery are both produced from clays, yet it may be thought that the former is very superior to the latter. This depends upon the skill of the workman.

Porcelain consists of a fusible earthy mixture along with an infusible. In the kiln these become semi-vitrified and translucent. Pottery consists of an infusible earth which when heated in the kiln remains opaque.

Varieties of porcelain and pottery may differ from each other in the stages and processes of their manufacture, yet there are general principles and details that are common to them both.

The clay in the hands of a skilful potter may be wrought into a work of art that will equal if not excel that done in porcelain. The life of Palissy the potter, and the work of our own Tinworth show that this is the case.

The great value and utility of felspar or china clay cannot be seen to better advantage than by a careful study of the lives of such men as Palissy, Josiah Wedgwood, or a visit to Doulton's show-rooms.

A surprising amount of history and insight to the manners and customs of extinct nations is obtained through the medium of clay used in the

potter's art. If no other record had been transmitted to us, we could have traced the extent of the boundaries of the Mahommedan empire in the Old World, and those of the Aztec in the New World, by the pottery they left behind.

Much the same may be said of the Babylonians and other ancient nations. In the old British Museum we have in clay letters of all kinds, which in themselves supply a great insight into the habits and customs of these peoples.

More strange still is the fact that the advance made towards civilisation by prehistoric peoples may be traced, owing to urns and other vessels which they made of clay.

The most ancient show distinctly that they had no knowledge of the potter's wheel, and that they fashioned the vessels with the hand, and decorated them with a stick, bone, or thong ; similar vessels are made at the present time by certain nomadic tribes in South America.

It would be impossible in such a brief article to describe the processes of painting under and over glaze, or to show the great opportunities and advantages this kind of work opens up to ladies with talent for art.

We have also omitted all reference to the thousand other ways in which this clay is used ; but sufficient has been said to indicate that felspar,

although forming a constituent of granite and kindred rocks, yields a clay that is second to none in usefulness to the human race.

CHAPTER XXII

Chloride of Sodium and Serpentine

FRENCH people are not allowed to take a gallon of sea-water to their homes, and if any person in that land of liberty, equality, and fraternity should violate this law, he would be liable to a fine or imprisonment.

This does not arise from any scarcity of sea-water on the French coast; for if every man, woman, and child in France were to take a thousand gallons, I don't suppose that England would be in danger of losing its insularity, nor would the level of the Atlantic be perceptibly altered. But the French Government holds all rights and claims as to the disposal of the ingredient named at the head of this article, and which is an aristocratically scientific name for 'common salt.'

To take away sea-water for any purpose whatever brings you under the suspicion that you are going

to clandestinely extract salt for your consumption. There is a heavy duty on salt, so you must purchase it in the regulation manner.

In countries which have no natural deposits of salt it is necessary to resort to a system of evaporation. In hot climates every three hundred gallons of sea-water affords nearly a bushel of salt. In New York State there are salt-springs that yield a bushel of salt out of every forty gallons of water.

The Great Salt Lake of Utah, which has an area of 2,000 square miles, is situated towards the summit of the Rocky Mountains, at an elevation of 4,200 feet above the sea, yet its waters contain twenty per cent. by weight of common salt in solution.

The waters of the Dead Sea contain from twenty to twenty-six per cent. of solid matter, about one-third of which is common salt. The saline condition of both these waters will be realised when compared with ordinary sea-water, which contains about three per cent. of common salt.

As regards those beds of salt covering large areas in certain rocks in each of the continents, it has been a matter of division of opinion among geologists as to whether the salt is the direct result of deposition from water, or the product of upheaval from the interior of the earth.

That salt in most cases must be a gradually formed deposit is evident from the fact that fossilised vegetation, several forms of tiny shells of foraminifera, and even small beetles have been found in layers of underground salt, and in the clay immediately adjoining it. These objects could hardly have emanated from the earth's interior.

Salt is generally found below beds of gypsum.

In the Pyrenees there are hills of salt 400 feet high. Salt is widely distributed in Nature, and is a most useful mineral. Whole districts of Austria have underlying beds of this valuable commodity.

Although the soils of large tracts of northern Africa are impregnated with salt, yet there are wide areas where it has not been found. To the peoples of these regions it is imported as a valuable substance, and is often used by them as a medium of barter.

Our salt-mines in Cheshire were worked as early as the time of Edward the Confessor.

By far the most remarkable of all salt-mines is that of Wieliczka, in Galicia. This has been continuously worked for 650 years, and still has sufficient salt to supply the whole world for several centuries to come. It is more than a mile long and half a mile wide. Its deep subterranean regions are excavated into a sort of town. For here are houses,

churches, and chapels, all made of salt. Statues, seats, and many ornamental objects of salt with decorated pillars of salt are in every direction.

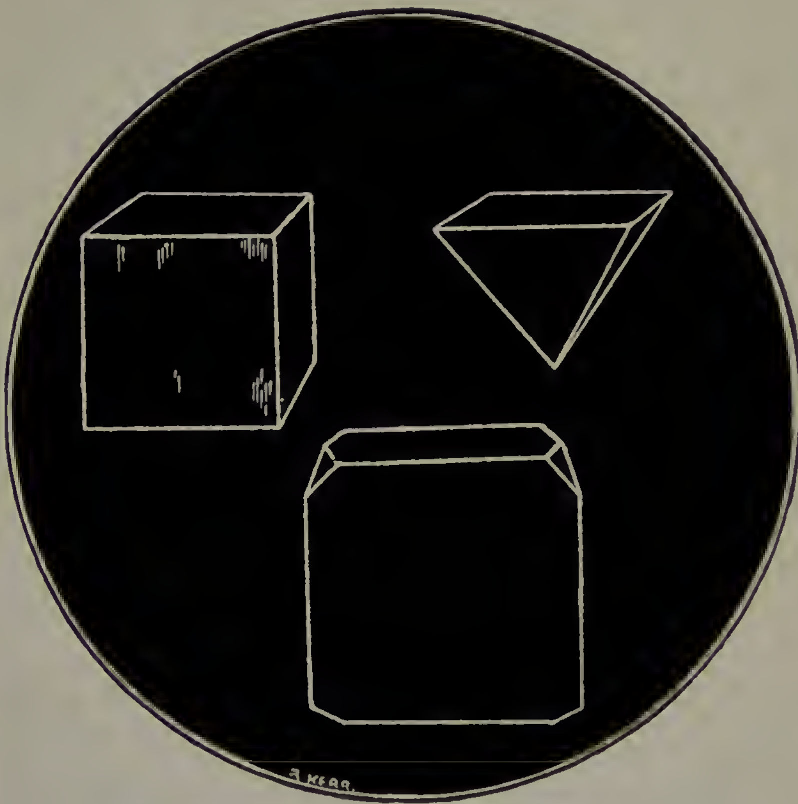

FIG. 66. CRYSTALS OF SALT

Every portion of this underground excavation is illuminated by lamps and torches. The effect is one of splendid and imposing beauty.

Salt crystallises in cubes (see fig. 66). Some

crystals are as clear as a block of pure glass, others are tinged with red, green, blue, and yellow. Occasionally four-sided cup-shaped crystals are formed floating on the brine.

Salt is the only mineral food, excepting water, that is capable of assimilation by man. It is an essential constituent of the blood, and all animals appear to like it.

Serpentine

Although a very beautiful rock and useful in a hundred ways, serpentine is not sufficiently durable for building purposes, neither is it adapted to the external ornamentation of buildings. Even when highly polished and employed as pillars or shop-front frames, it soon loses its polish and wears unevenly.

Owing to its beautiful colours and to the ease with which it can be carved and worked in the lathe, it is greatly sought after for mantelpieces, tables, ornamental indoor work, as well as for mantel ornaments, vases, inkstands, miniature fonts, egg ovals, candlesticks, letter weights.

When serpentine is breathed upon it gives off a clayey odour, not unlike that recognised in hot summer weather after the water-cart has sprinkled the dusty roads. Owing to its clayey smell the genuine serpentine may be distinguished from inferior imitations in composition.

The rock is more or less greasy to the touch, owing to the presence of *steatite*, or soapstone.

All kinds of serpentine when polished are known as marble, and some varieties are called Verde Antique. Many of the ornaments formerly made by the Maoris of New Zealand, and thought to be pure jade, are only hardened varieties of serpentine.

The Precious or Noble Serpentine is much more valuable, is translucent when massive, and is a very beautiful rock when polished.

The Common Serpentine is always opaque. It occurs in many countries.

The rocks best known to Englishmen are those of Kynance Cove, the Lizard, Cadgwith, and Coverack in Cornwall, and the serpentine of Shetland and the Highlands of Scotland.

Formerly it was exported in large quantities from Portsoy, in Scotland, to be manufactured for ornamental purposes. It can be readily wrought in the lathe. It occurs in many districts of North America.

The serpentine cliffs of the Lizard coast are so rich in colour that artists and writers alike fail to give more than a meagre idea of their beauty. A holiday spent at the Lizard will leave lasting and enjoyable impressions. Most of the inhabitants not engaged in fishing have their lathes

and apparatus for working up the serpentine during the winter months into saleable articles ready for summer visitors.

One cannot refrain from bearing testimony to the civility and industry of the people of this district, and to their desire at all times to show kindness to strangers. The scenery of Kynance Cove and the Lizard is matchless, filling one with wonder at the natural display of beauty in cliff, in sea, and on the foreshore, and also causing one to marvel why people who have never seen these wonders and beauties spend their holidays at insanitary places on the Continent.

The composition of serpentine is as follows :—

$$\left.\begin{array}{lcr} \text{Silica} & = & 42{\cdot}3 \\ \text{Magnesia} & = & 44{\cdot}2 \\ \text{Iron} & = & 0{\cdot}2 \\ \text{Carbonic Acid} & = & 0{\cdot}9 \\ \text{Water} & = & 12{\cdot}4 \end{array}\right\} 100$$

CHAPTER XXIII

Gypsum and Dolomite

GYPSUM is a most useful stone, and in one form or other is found in every country of the world. Its chief varieties are Selenite, Alabaster, and Satin Spar.

As SELENITE it is as clear as glass, and may be split into leaves thinner than the finest notepaper. These thin layers glisten with a sheen more perfect than that produced by a lapidary in polishing gems of great value.

In this transparent condition it is invaluable to opticians, in the construction of polariscopes, whether for use as separate instruments, for polarising light, or for accessories to the compound microscope.

Many of the wonderful phenomena connected with light have been elucidated through the agency of these thin laminæ of selenite. This word is derived from *selene*, the Greek for moon, in allusion to its lustre and colour. The student working

with his microscope in the examination of various forms of minute crystals of chemical substances continually interposes plates of selenite in order to obtain greater definition and displays of colour not producible by any other means.

As ALABASTER, which is a massive variety of gypsum, it is cut into vases, statuettes, and various ornaments, and may be worked in a turner's lathe. Its whiteness, fine texture, comparative softness, and its capability of receiving a high polish, contribute to its beauty and utility. From the earliest times it has been carved into boxes for holding ointment, trinkets, etc.

As SATIN SPAR it is prized for cabinet specimens, and needs no polishing, for wherever it is fractured it displays a natural lustre, comparable to that of the manufactured article after which it is called.

All varieties of gypsum, when heated, give off their water of crystallisation, and may be reduced to a powder known as 'Plaster of Paris.' When mixed with a little water it rapidly dries and becomes hard and compact. It is much used for taking casts, for making models, and for various artistic purposes. It is also constantly used in connection with surgical operations in hospitals. In the interior decoration of dwellings it is most valuable for giving a *hard finish* and fine surface to walls and for various mural and ceiling devices.

In chemists' language it is called 'hydrated sulphate of calcium,' which means that gypsum contains lime, sulphuric acid, and water. To be more accurate still, there are in every hundred parts of gypsum 46·5 parts of sulphuric acid, 32·6 of lime, and 20·9 of water.

This mysterious synthetic power or building-up process of Nature, by which chemical substances are united to form solid materials that are both beautiful and useful, is almost as wonderful as life itself, and must make the thoughtful student realise his own impotency in all his efforts to build up as Nature does.

Concentrated salt-waters, whether derived from brine-springs or connected with sea or inland lakes, deposit gypsum, so that wherever salt is deposited in the strata of the earth, or wherever brine-springs occur, a deposit of gypsum is almost certain to be present.

The decomposition of iron pyrites (iron and sulphur) in chalk rocks brings about a union of sulphuric acid and lime, which substances with water are, as we have shown, the component parts of gypsum. This valuable rock is also formed by the action of sulphurous vapours on lime wherever volcanic disturbances occur near calcareous or lime-stone rocks. Massive and beautiful crystals of selenite may be found on the sea-shore between

Herne Bay and Reculver—some are over 10 inches in length. In some localities, however, layers of selenite have been found quite a yard across (fig. 67).

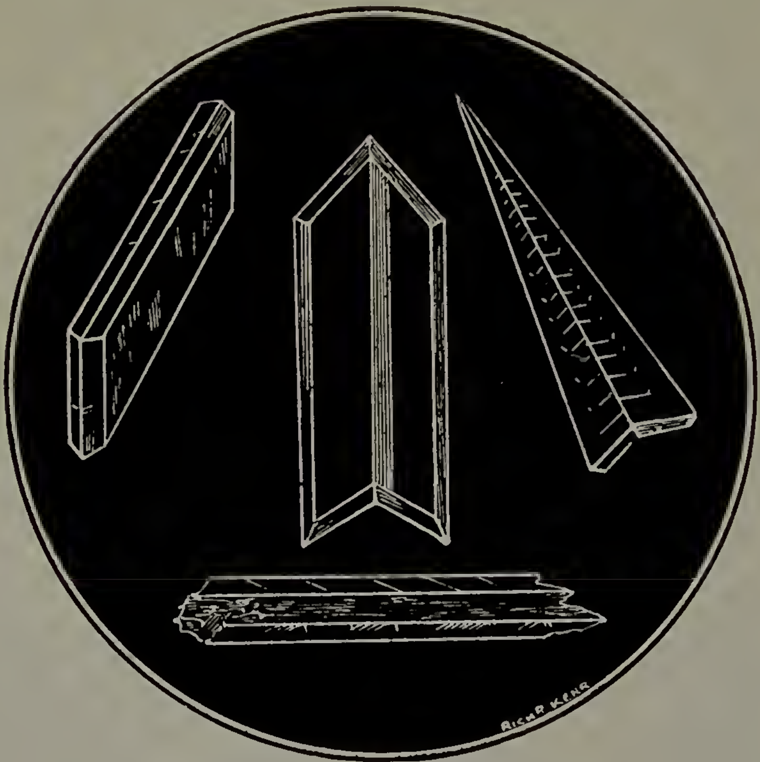

Fig. 67. Crystals of Selenite

Beautiful crystals have been taken from the clay of Shotover, near Oxford, and at Chatley, near Bath.

Crystals of gypsum may be seen to form on

evaporating a drop of sea-water in the field of a microscope.

The law of crystallisation applies in the geometrical arrangement of the atoms of gypsum, suspended in the microscopical particle of water, as in the formation of the most gigantic crystals.

A very large crystal of selenite from Gotha, presented by H.R.H. the late Prince Consort, is to be seen in the Pavilion of the Mineral Department of the Natural History Museum.

Dolomite

Some few years ago, when attempts were made to blow up the British Houses of Parliament by placing explosive bombs in and about the building, it would have been more scientific to have applied some thousands of carboys of sulphuric acid, and to have thereby changed the edifice into *Epsom Salts*, for the building material contains nearly fifty per cent. of carbonate of magnesia.

For once the effervescent outbursts of certain members would be eclipsed by an effervescence on a grander scale, and we should have so much Epsom Salts in London that an American company would be sure to form a ring and dictate to us the price we should pay for that medicinal article. It is a curious fact that the building material of these famous structures as well as that of York

Minster, of Milan Cathedral, and of many other public buildings contains, about the same percentage of carbonate of magnesia.

Dolomite (magnesian limestone) consists of carbonate of magnesia 45·6 and carbonate of lime 54·4. The Parian marble is supposed to belong to this species of rock, and the same may be said of the Iona marble in the Hebrides.

Many geologists consider that dolomite has been produced by the action of volcanic gases on common limestone. The calcareous blocks ejected from Vesuvius are very similar in character. There are whole mountain masses of dolomite in the Tyrol.

It is hard to realise that the famous Dolomite Mountains had their origin as reefs of coral in an ancient ocean. Yet with many this is an accepted theory.

CHAPTER XXIV

Mechanical Products of Nature and Fulgurites

IF I had not seen the objects as represented (fig. 68) in the actual process of manufacture in Nature's workship, I should have imagined them to have been produced by some kind of marine worm such as the serpula. These and many hundreds of similar rings were turned out, as it were, simultaneously while I was looking on, and all without the aid of any creature whatever—all, in fact, the result of Nature's mechanics.

To understand the process, the reader must accompany me in imagination to the banks of the River Shannon, where these were formed, and where the grass is very wiry. At times the river overflows its banks, and the water, carrying a solution of white mud, spreads over the fields, leaving as it subsides a thin layer of this deposit, which resembles fine white sand, but partakes of the nature of clay in that it is adhesive. The

wiry grass is covered over for a time, but, owing to its growing powers and the natural strength

Fig. 68. Mechanical Products of Nature

of the stems, the plants force their way up through the layer.

Now, let us watch one stem, and if we can

appreciate its motions, we shall be able to understand how hundreds of rings are formed.

The seed-vessels on the top of the stem, on rearing themselves up through the soft clay, carry in their meshes some of the soft material, which, as we have said, is of an adhesive nature, so that the plant is top-heavy, and is bent over to the shape of half the circumference of a circle. The wind blows, and as a result the plant rotates, and as the clay attached to the top of the plant is dried sooner than the layer on the ground below, owing to its more elevated and exposed position, it becomes hard, and scratches the soft clay like the pencil or free end of a pair of compasses. Very soon its movements in a circular direction backwards and forwards, entirely owing to the action of the wind and the elasticity of the plant, cut out a circular piece of the clay like a coin with a hole in the centre. The centre hole is the result of the movements of the stem.

Several concentric rings may be worked out by the one plant, according to the number of pieces of clay that become attached to the seed-vessels. In this manner a whole area may become covered with these rings, varying in size from $\frac{1}{2}$ inch to 3 or 4 inches in diameter.

Thinking that specimens of the rings might

throw light on other mechanical products of Nature, I have kept a number of them by me for several years, and now for the first time I find a parallel instance in certain specimens under the heading of this article in one of the window-cases of the Mineral Department of the Natural History Museum. The shapes of those in this glass-case are very wonderful, and look as if worked out on a lathe or certainly done with definite intention. It is not stated how these in the Museum have been formed.

Doubtless many instances will occur to the minds of my readers of the mechanical products of Nature on a large scale, such as the formation of natural bridges, caused either by running water, the hammering power of ocean waves, or the boring action of sand blown by wind, etc.

The subject opens up useful channels for observation, although at first it may have appeared an insignificant matter to describe the formation of a 'mud ring.'

Fulgurites

Fulgurites are remarkable formations known also as *lightning tubes*. They are the result of the action of lightning on wet sand or on rocks high up on mountain peaks. Several have been found on Mont Blanc and on Monte Viso at the height of over 12,000 feet.

Some of the fulgurites found on the latter mountain are over 6 inches long and nearly 2 inches wide. The electric flash entering the sand fuses the passage-walls, and generally leaves a number of glass globules along the surface. These globules frequently have minute holes through which gas has escaped, owing to the heat of the electric current. There is no alteration of the sand or rock except on the actual surface itself.

That fulgurites have not been formed by any artificial means is evident from the situation in which they have been found.

The whole process of the formation of some fulgurites, including the heating, cooling, and contraction, must take place with extraordinary rapidity as they show no traces of crystallites. For this reason the glass globules of these particular fulgurites are probably the purest natural glass ever formed. But there are fulgurites, notably some of those from Monte Viso, which contain rod-like bodies like crystallites of garnet.

For a long time the fulgurites were a complete puzzle to mineralogists, and also to geologists. The biologists could throw no light on their history, as there were no traces whatever of animal or vegetable life in their composition, nor could they find any workings on them to indicate any action of an organic character.

Fig. 69, No. 1, shows one of the fulgurites. At times two or three tubes are found joined together side by side like so many organ pipes.

CHAPTER XXV

Meteorites, Geodes, Gold, and Diamond

MINERALS or stones which fall to the earth from outer space must be reckoned among objects that arouse a great deal of curiosity. Oddly enough, neither scientific men nor the people in general gave meteorites a thought, or believed such things possible, until about the beginning of the century just ended. As a matter of course there were no meteorite collections anywhere, for every one was incredulous as to reports of stones falling from the sky.

The British Museum had none in its collections for fifty years after its foundation. Meteorites in those days were looked upon as native iron. In 1807 the British Museum had less than half a dozen of these remarkable specimens.

During the thirty-eight years that Charles König had charge of the National Collections about sixty-three meteorites were added. From 1851 to 1857

only three meteorites were added, the keeper of the department being C. R. Waterhouse, whose energies were chiefly directed to the development of a more useful branch of study—the Geological collections. Under Professor Story Maskelyne's keepership the number of meteorites was more than trebled in less than six years. He was ably assisted by the late Thomas Davies.

The collection at the present time, which occupies the main portion of a special pavilion off the Mineral Gallery, is the result of many donations and purchases, and is looked upon as excellent, both in point of numbers and as a representative collection.

One of the meteorites, that found in 1891, at Cañon Diablo, Arizona, contains a diamond!

Meteorites entering our atmosphere from the sky do not reach the earth with that terrific force which we naturally attribute to them.

The famous Milan astronomer, Schiaparelli, and Professor A. S. Herschel have shown that the resistance of our atmosphere, while reducing a meteorite in bulk by fusion and volatilization, would also reduce its velocity to that of a few hundred feet a second by the time it approached the earth. Meteorites have been known to fall upon ice only a few inches in thickness, that have rebounded without falling to pieces or even breaking the ice.

As a rule, meteorites are not spherical, nor have they any definite shape. They are generally irregular and angular.

Meteorites do not necessarily fall during thunder storms. They are liable to fall at any time and in any locality. Generally a loud crashing report

FIG. 69. (1) FULGURITE, (2) METEORITE, (3) GEODE, (4) GOLD CRYSTAL, (5) DIAMOND

like that of thunder accompanies their arrival in our atmosphere.

A very remarkable occurrence took place at Butsura, May 12, 1861. Three distinct detonations were heard sixty miles away, and fragments of stone were picked up in an area three or four miles in diameter, which when placed together

fitted exactly, showing the possibility of completing the whole meteorite if all the fragments could be obtained. A model of the reconstructed portion is to be seen in one of the glass-cases.

When a meteorite is cut through and polished, it shows figures that are called into existence by the action of acids, etc., used in polishing, on the various constituents, thus showing the meteorites to be composed of different kinds of substances.

Notwithstanding all that has been said to the contrary, our ablest men of science are confident that no traces of organised matter exist on any of the meteorites as yet examined.

According to research, by means of the spectroscope, all the heavenly bodies are constituted of the same kinds of elementary matter, the meteorites included. If there be any difference, it is solely a question of heat, therefore we do not expect to find new elements even in stones or minerals that come from outer space.

For those who wish to follow this subject further, the *Introduction to the Study of Meteorites*, published by the trustees of the Natural History Museum, will be found intensely interesting and invaluable. The few facts I have brought together under this heading are mainly from that capital work. A meteorite from Mexico is shown in No. 2, fig. 69.

Geodes

No. 3 in fig. 69 represents a small geode. It contains chalcedony in the form of small stalactites. Very large geodes of that kind have been found on the banks of the Fox River, U.S.A., and several, but lined with crystals of quartz, have been taken from the rocks near Clifton Suspension Bridge.

Evidently the geode was formed in a hollow space in a rock. If we could go back and view the whole history of its formation, it might be found to cover a period of scores of thousands of years.

Most likely a sponge, or other marine animal, became covered up with a marine deposit. Layer after layer had been laid down gradually. In a duration of time, unknown to man's limited experience, this deposit, extending over a large area, had been lifted up, or, what amounts to the same result, the waters subsided, the deposit became hardened into a solid limestone rock. The sponge had long before passed away, but the space it occupied was left. The remains of the sponge may have acted as a nucleus, around which an accumulation of silica (quartz) was gathered, the cavity received a thin lining of the substance, then another thin layer was deposited on this, and so on until the space was lined to the extent of a quarter of an inch or so. The supply of silica may have found its way in water percolating through some tiny crevice or hole.

Crystals of chalcedony, a pure form of silica, had gradually formed until the cavity was represented by a ball of silica, much harder than the rock in which all this took place. The outer rock of limestone is broken up for building or other material, and the ball, potato-stone, or geode, rolls out of its matrix. When the geode is broken open and the two parts placed side by side, showing crystals of quartz or of pure chalcedony, the potato-stone becomes a very attractive object. During the cutting of the railway and boring the rocks at Cotham Down, near Clifton, some years ago, these potato-stones were to be had for a shilling or two.

All this about the formation of a geode is a theory, and one ought not to force it, nor in any way to dogmatise upon any such point.

Gold

Gold is one of the most remarkable of all minerals. It is so wonderfully ductile and malleable. It can be hammered out so thin that it appears of a green colour in transmitted light, and it can be drawn into wire of microscopic fineness. It is found in various forms, such as wire-like, in branches, interlacing and moss-like, and sometimes in small crystals. No. 4 in fig. 69 represents a crystal of gold from California.

It is one of the most widely distributed minerals,

and is found in beds, veins, or nests, generally of small extent, or mechanically mixed with granite, syenite, greenstone, clayslate, and quartz. It is found in the beds of rivers in various parts of the world, and even in the stream works in various parts of Cornwall, and in Wales and Scotland.

The varieties of gold containing more than twenty per cent. of silver are distinguished under the name of *electrum* or *argentiferous* gold.

The largest nuggets of gold have been found in Australia and California.

Gold is soft, very heavy, and does not rust. It has to be mixed with an alloy of silver and copper for coins, on account of its great softness. Two parts of the alloy go to twenty-two of gold to make standard gold. Forty-six sovereigns weigh one pound of gold. Gold is valued by the Government at £3 17*s.* 10½*d.* per ounce. Jeweller's gold contains from sixteen to twenty parts of pure metal, reckoning twenty-four parts to represent pure gold.

Gold can be hammered out by machinery so that two hundred thousand sheets would only be about one inch in thickness. It is nineteen times heavier than water, and is, with one or two exceptions, the heaviest of all metals.

Diamond

Mineralogists do not know how the diamond

has been produced in Nature—and it is even doubtful whether it has ever been found in the place where it was originally formed.

Diamond is pure carbon. Graphite, also known as plumbago, or blacklead, is also carbon, but not so pure as the diamond. The small difference between the diamond and graphite is, however, sufficient to render them utterly unlike in appearance. Graphite is black and opaque, the diamond is clear and transparent. Graphite is soft, in fact one of the softest of rocks, while the diamond is the hardest of all known rocks. Graphite is an excellent conductor of electricity, the diamond is a very bad one.

The diamond is regarded as the most precious of all decorative stones, and it is remarkable that its great polish is obtained by means of its own powder. Nowadays the chief supply of diamonds comes from Brazil and South Africa.

Diamonds are much more plentiful than people are aware ; but it is to the interests of the great firms that have formed themselves into diamond trusts to keep the supply, so far as the public is concerned, regulated with mathematical nicety, so that even though the output of diamonds may be enormous, the price is steadily rising. Were it not so, everybody could have diamonds. They would very soon be thought little of, and would probably

become commonplace. The sellers of diamonds are the owners of the mines, and they have no intention of allowing the market to be glutted with cheap stones. Perhaps it is just as well.

The Kimberley mines yield, it is thought, more than four million pounds' worth of diamonds annually, to say nothing of the supplies from Brazil and elsewhere.

No. 5 in fig. 69 represents a diamond in one of its natural forms of crystallisation.

Conclusion

IN the foregoing pages we have noticed a number of curious plants, curious creatures, both land and marine, and a number of specimens representing branches of the mineral kingdom.

In them we cannot fail to see, notwithstanding the superficial way these various objects have been described, evidences of a Power overruling even the humblest organism or the simplest crystal—a Power that produces marvellous designs in the animate and in the inanimate, and that controls the laws which govern their development. There are very clever theories—the result of man's research—which are always helpful in our study of Nature, if, over and above all theories, we ever recognise the Omnipresence of God. Let this be the rule, whether we are studying the microscopic object, the plant, the creature, the mineral, or the far-off star.

From the mechanism of the tiny insect right up to the mechanism of the heavens all depends upon the sustaining power of our all-wise Creator.

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